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Compressed Air Magazine

Vol. XXIX, No. I London New York Paris 35 Cents a Copy

JANUARY, 1924

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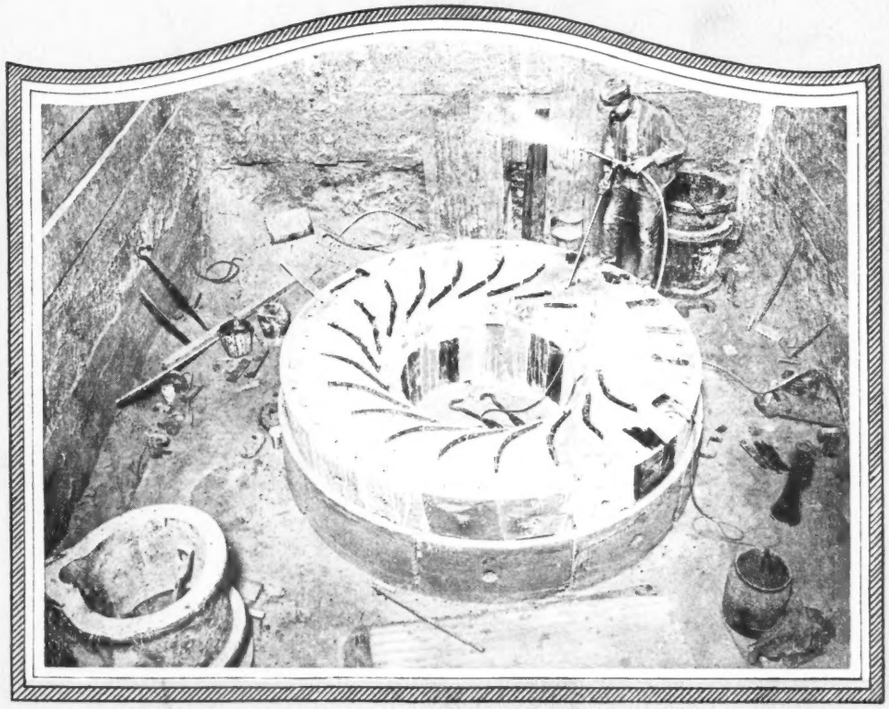

SIPHONING DUST AND DIRT BY MEANS OF COMPRESSED AIR FROM INACCESSIBLE PARTS OF AN INTRICATE WATER-WHEEL MOLD

Speeding Up the Production of Large and Superior Steel Castings
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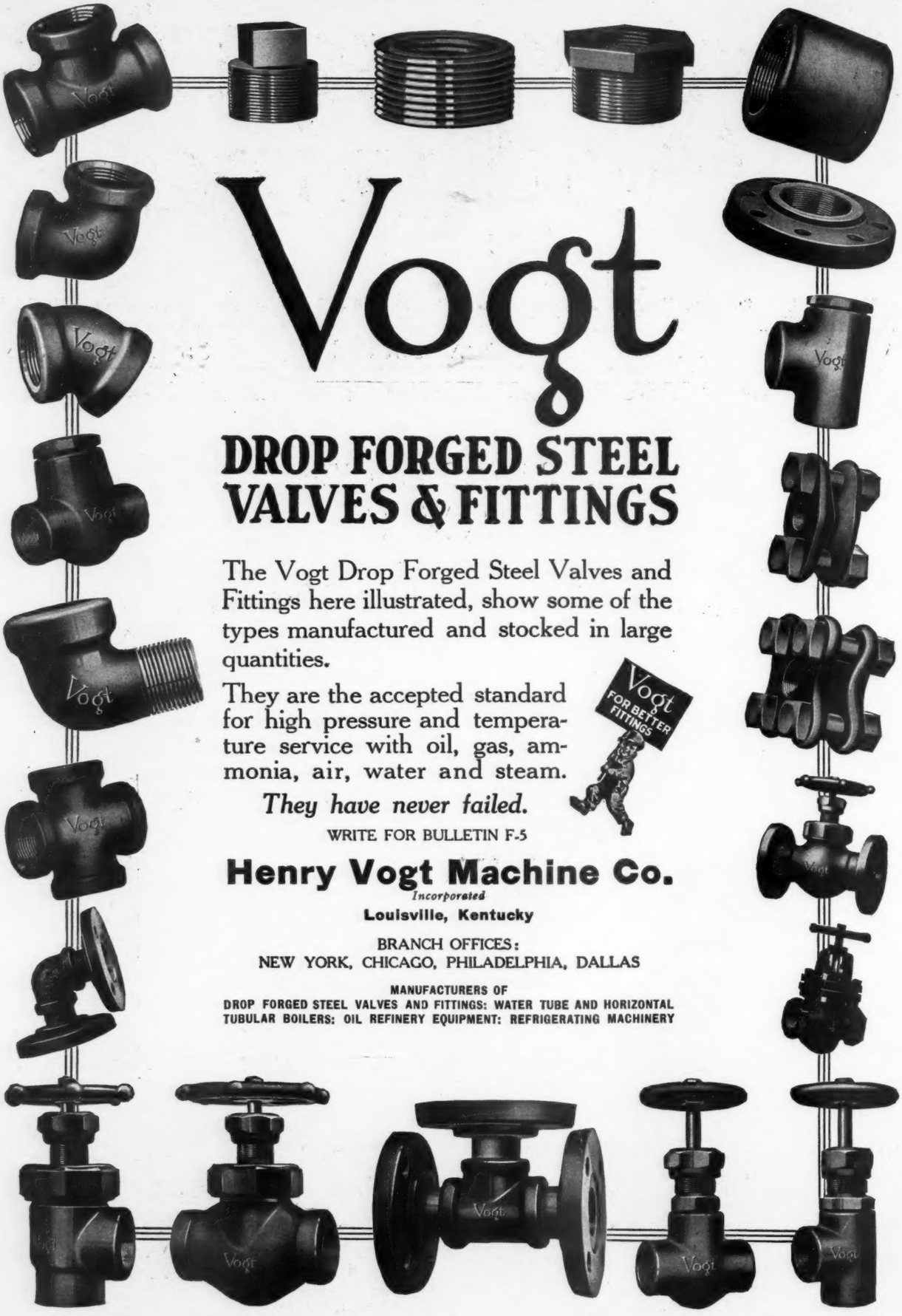

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No. 11, BROADWAY,
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VOL. XXIX, NO. I

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Compressed Air Magazine Co.
JANUARY, 1924

Speeding Up the Production of Large and Superior Steel Castings

The Wheeling Mold & Foundry Company, of Wheeling, W. Va., is Fully Alive to the Gains Made Possible by Compressed Air and Pneumatic Tools

By S. G. ROBERTS

WHERE large castings of superior strength are required it is customary to make them of steel. The reasons for this are twofold: first, the steel per unit of weight or section is stronger than a similar mass of cast iron; and, next, the composition of the steel can be so varied, agreeably to its percentage of carbon or other alloying agents, as to give the metal distinctive properties which will fit it for some special application or particular service.

But this adaptability of steel is offset, as far as the foundry is concerned, by certain drawbacks which necessitate decidedly careful handling of the metal just before pouring and which also entail very exacting work in preparing the molds for the castings. The gravity of the latter requirement grows as the size of the casting increases, because the volume of metal involved and the intense heat of the molten steel bring in their train conditions which have to be met. Let us explain.

While there is not a great difference between the melting point of iron and that of steel, still there is a marked difference in the temperature range within which the two metals can be poured to produce a satisfactory casting. That is to say, iron can be held in the ladle for a longer time and cool off more than steel and yet be hot enough at the end of that period to flow freely and to form a perfect casting. To obtain the same results with steel, the temperature at the moment of casting must be anywhere from 700 to 1,000°F. higher than that of molten iron. This difference in temperature is troublesome, and must be given heed in the forming of the mold lest the sand of the facing be fused and so combined with the skin of the casting as to cause imperfections or roughness which can be removed only at considerable expense, if at all. Again, because the steel must be poured when incandescent and fluid, speed is essential in shifting the ladle from the furnace and in discharging its contents into the waiting molds, otherwise many tons of metal, hours of time, and much fuel may be wasted.

THE functions of compressed air and pneumatic tools in an iron foundry were covered by an article in the preceding issue of the Magazine. In this number we deal with the helpful services performed by these agencies in a great steel foundry.

A steel foundry imposes conditions which differ more or less radically from those prevailing in an iron foundry, although the metals used in these plants are of the same base.

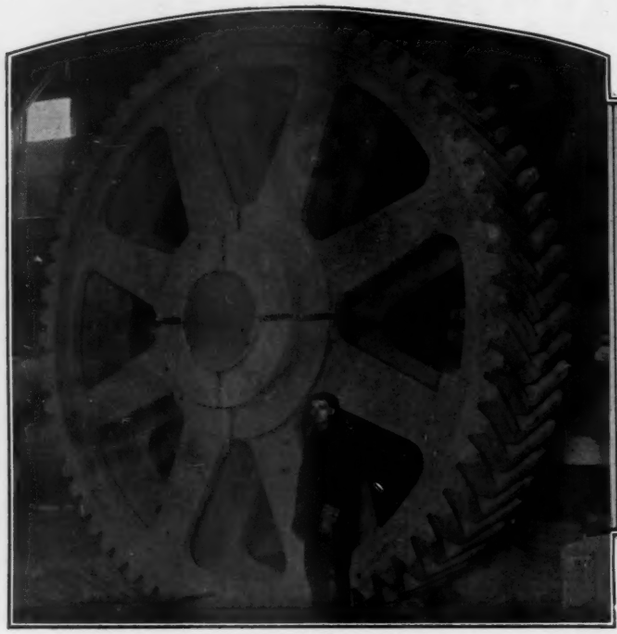
In the particular foundry we are about to describe, compressed air and pneumatic tools make it practicable to do work which would not be undertaken in the absence of these essentially modern conveniences. Not only are time and money saved by these labor-saving aids but large castings of a complicated character can be turned out rapidly with every assurance of success.

The Wheeling Mold & Foundry Company of Wheeling, W. Va., has long been conspicuous in the industry by reason of the immensity and the character of many of the castings turned out by it. The monthly output is around 2,400 to 3,000 tons. These castings have largely to do with the equipping of big steel plants, great machine shops, and a very wide range of engineering projects of magnitude. To be specific, from this foundry are sent far and wide enormous castings for canal locks, hydro-electric installations, battleship armaments, mounts and associate features for the heaviest of coast-defense guns, segments for subaqueous tunnel linings, etc.

Steel castings weighing from 10,000 to 25,000 pounds are commonplaces in this plant, while some of 40,000 and 50,000 pounds are not infrequently produced. The biggest casting yet turned out by the foundry was a cast-iron armor-plate mold made for the United State Naval Ordnance Plant, Charleston, W. Va., during the World War. This casting weighed 275,000 pounds, and its external dimensions were approximately 16x16x10 feet. To provide the metal for products of large size, the plant is equipped with three furnaces: one having a capacity of 125,000 pounds and the two others being capable of furnishing 25,000 pounds each every 24 hours.

It is probably not overstating the case to say that the Wheeling Mold & Foundry Company has reached its present preëminence in its chosen field mainly because its management early recognized what compressed air and pneumatic tools could do towards speeding up production and in making it feasible to handle confidently jobs of the largest sizes. Indeed, when several of the departmental heads were asked how long it would take them to do certain pieces of work without pneumatic tools, each and all of them emphatically declared that the work just could not be done—would not be undertaken—without these modern and essential aids. In other words, handwork, as the term is understood in the foundry, would be wholly unequal to cope with such tasks except at a prohibitive cost.

It may not be commonly known, but the Wheeling Mold & Foundry Company has been a pioneer in producing cast segments for subaqueous tunnel linings, and from this source came many thousands of tons of these units for the tunnels underlying the rivers on each



The big herringbone gear wheel for driving the mill pinion of a steel rolling mill.

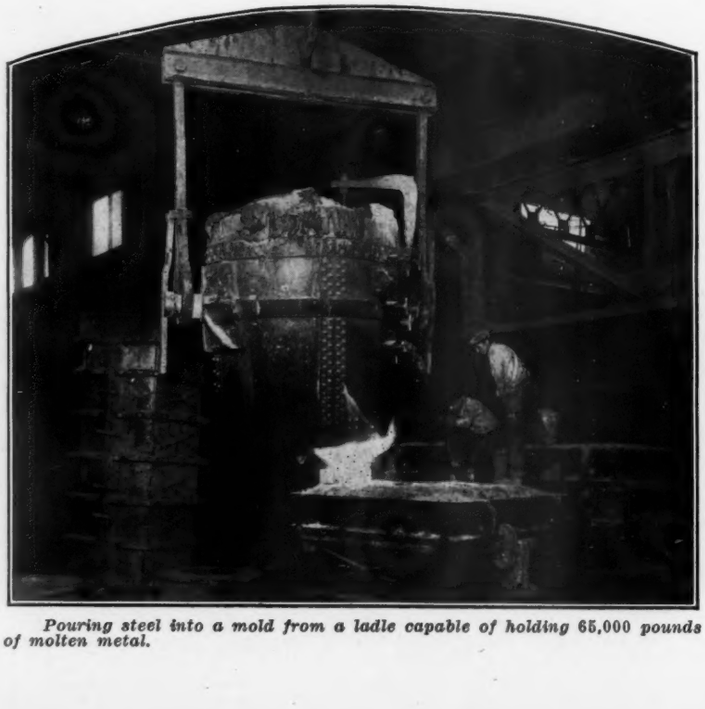
A mill pinion weighing 40,000 pounds, part of the equipment for a steel plant.

side of the Borough of Manhattan of Greater New York. At the start, the molds for these segments—each of which weighed a ton—were rammed by hand, and one man and his helper, by working hard and steadily, were able to prepare five molds a day. Recognizing that this was expensive and rather slow, the management wisely decided to install a pneumatically operated jolting machine for packing the sand in the flasks. With this apparatus at their disposal, it was soon found practicable for five men in the course of a working day to turn out between 100 and 105 molds ready for pouring! That is to say, production was increased more than 800 per cent. As might be expected, the jolting machine has been used continually ever since and has been instrumental in effecting very substantial savings.

In making up a mold, it is essential that the molder pack his sand so firmly about the pattern that the sandy mass will afterwards resist displacement when sustaining the weight of the metal poured into it to form the desired casting. Manifestly, the need of rigidity in the surrounding sand increases directly with the weight of the casting to be formed, for any subsidence or movement of the sand at a critical stage in the pouring might seriously damage the casting in the making and not only cause delay but lead to the loss of a large amount of money.

Take, for example, the spider for a great electric generator—the intricate wheel-like casting which carries the numerous coils of one of the two fundamental parts of a dynamo. Here we have a mass of metal weighing 150,000 pounds which, owing to the nature of the service expected of it, must be exact in form and true in the balanced distribution of the material composing it, otherwise it would be incapable of running with that remarkable smoothness and uniformity of movement essential to the proper functioning of electric generators and motors. The spider is composed of two castings which, when brought together and secured to each other, constitute the rapidly whirling central element of a dynamo. It should be plain that the sand in the mold must be packed with much care and firmness to make sure that it will carry the metallic load. Fortunately, the air-operated floor rammer has made it practicable to satisfy these requirements and to perform the needful work rapidly. This is not hard to understand when we recall that the average hand-tamped blow does not exceed 18-foot pounds, and a worker delivers about 40 blows a minute—meaning an aggregation of 720 foot-pounds of work in that interval. A floor rammer, on the other hand, is capable of delivering a total of 28,000 foot-pounds per minute—in short, doing substantially 40 times as much work in the period mentioned.

But this does not describe all the virtues of the floor rammer. The tool not only works faster but it rams the sand harder and, incidentally, produces a more homogeneous supporting body. Further, the rammer is so designed as to insure a minimum of vibration or reaction upon the man manipulating it; and while the blows are sharp and vigorous their number and their impact can be completely controlled by the throttle with which the tool is equipped. In others words, the action of the rammer is flexible and readily adaptable to the particular needs of a given job or a part of it. Bench rammers are utilized to pack the sand where it would be difficult if not impossible to employ the longer floor rammer; and, in its way, the penumatic bench rammer is also vastly superior to hand ramming because the air-driven tool can give 750 blows a minute. As an illustration of the gains made possible by pneumatic ramming, it used to take two men a 10-hour day to hand ram a single mold for a 60-inch steel mill roll.



Pouring steel into a mold from a ladle capable of holding 65,000 pounds of molten metal.

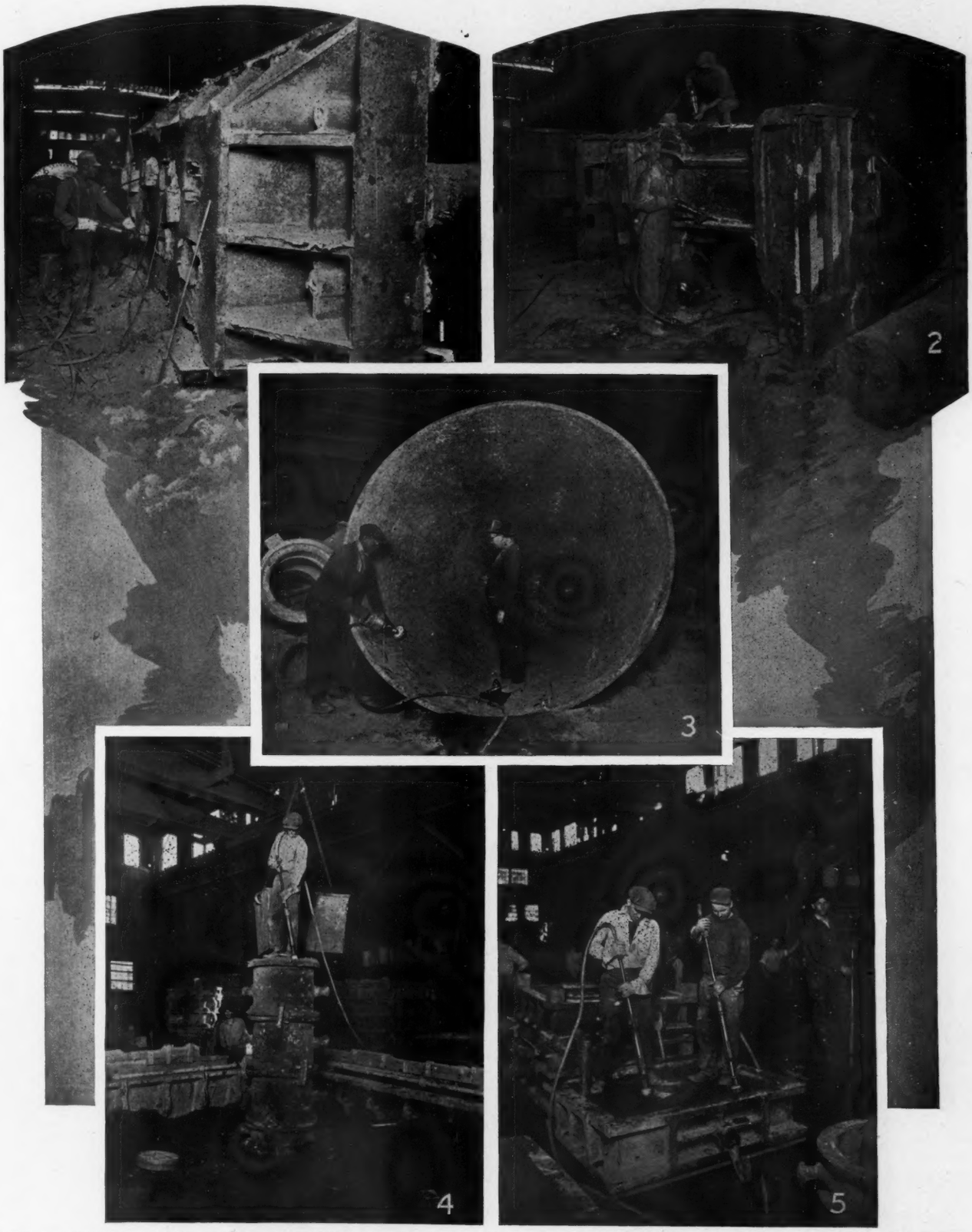
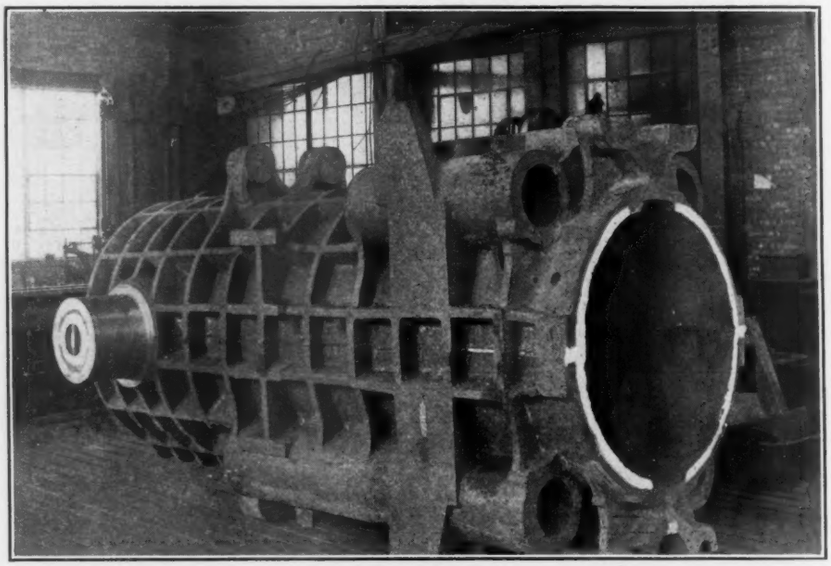
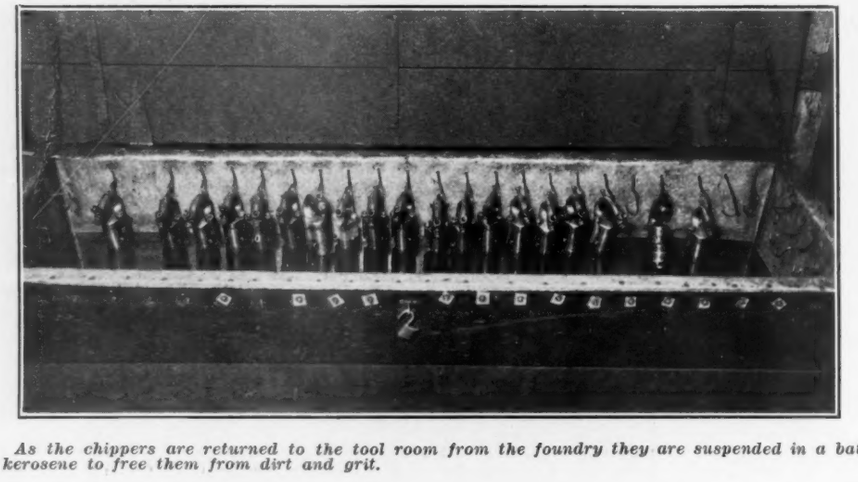


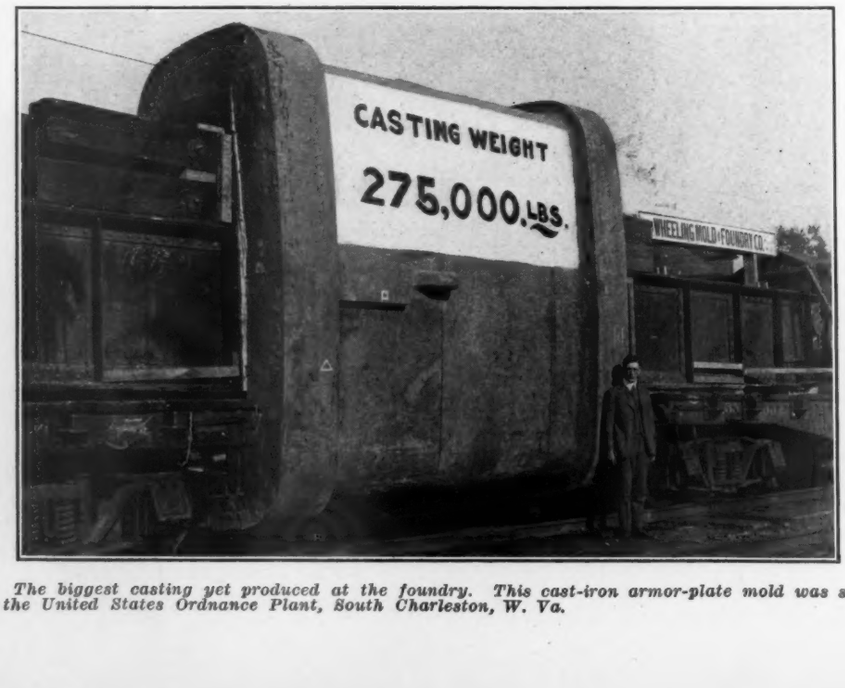
Fig. 1—Breaking out the cores in a large bridge casting. Fig. 2—Chipping one-half of the spider for a large electric generator. Fig. 3—Putting the finishing touches on the inner surface of a cinder ladle so that the slag will not stick to the ladle when the latter is tipped to empty it. Fig. 4—Ramming the mold of a steel-mill roll. Fig. 5—The pneumatic floor rammer is indispensable to the proper ramming of molds for big castings.



A complicated casting weighing 50,000 pounds. This is the cradle for a monster 16-inch coast-defense gun.



As the chippers are returned to the tool room from the foundry they are suspended in a bath of kerosene to free them from dirt and grit.



The biggest casting yet produced at the foundry. This cast-iron armor-plate mold was sent to the United States Ordnance Plant, South Charleston, W. Va.

Now, with an air-operated floor rammer, one man can do this work in an 8-hour day—representing a man-hour saving of 60 per cent.

Some of the castings in hand at the time of the writer's visit weighed as much as 88 tons apiece, and two of these had just been removed from the sand. They were parts of the saddles of the tower structures for the great Philadelphia-Camden bridge. There were a number of other castings ranging from 75 down to 20 tons each—a few of them being relatively simple in form while most of them were decidedly intricate and had called for the employment of rather complex cores. But all these castings had necessitated very careful tamping in order to guard against deformed and over-weight products. Pneumatic ramming of the sand had insured the desired results.

The facing of a mold—especially for a large steel casting—must be formed of sand having characteristics which make it peculiarly suited to foundry work of this exacting sort. Therefore, the best practice demands high-grade silica sand to which are added pulverized fire clay, silica flour, and molasses. This mixture provides the needful "body" and also insures those heat-resisting properties which enable the foundryman to turn out from the mold a reasonably clean casting.

The primary purpose in employing silica sand is to utilize a material composed of fairly large grains of uniform size and considerable hardness. This insures a sufficiently porous facing to facilitate the escape of gases generated by the molten metal. The fire clay, silica flour, and molasses serve to bind the grains of the silica sand so that the facing will be firm enough to support the weight of the incoming steel. Much skill has to be exercised in apportioning the binder so that the porosity of the sand will not be seriously reduced. It is customary to build up the facing of a large mold to a depth of an inch or two—depending, of course, upon the massiveness of the particular section in contact with the sand. The refractory, pulverized fire clay helps the sand to resist the fusing action of the intensely hot steel; and this protection is necessary because the volume of the metal may be such as to remain red hot for some while after it has entered the mold. If the sand were fused it would inevitably adhere to the surface of the steel body and prove extremely troublesome in cleaning the casting afterwards.

The layman may not realize how important it is to provide for the easy escape of the gases which form when a mold is poured. These gases, if they cannot readily find their way to the atmosphere, may produce weakening blowholes in the casting; and, when confined, they may even develop explosive or disruptive pressures which may render a casting utterly worthless. Again, the metal must be poured into a mold steadily and at such a temperature that the steel will flow freely into every interstice of the mold and not solidify and thus block a passage that ought to be filled. The successful making of a large and intricate casting demands much exacting preparation and speedy and expert work at the moment of pouring.

A further essential aid in making steel castings that will strip clean is the wash that is used in facing the molds. The importance of the wash is recognized by every foundryman, and when he has one that meets all of his requirements he usually guards jealously the secret of its composition. The Wheeling Mold & Foundry Company is no exception in this respect. On small molds the wash at that plant is commonly applied manually, but for the large and complicated molds the wash is blown on by a compressed air spray which enables the operator not only to cover considerable surfaces quickly but to distribute the mixture in recesses and other places that would be hard if not impossible to reach by hand.

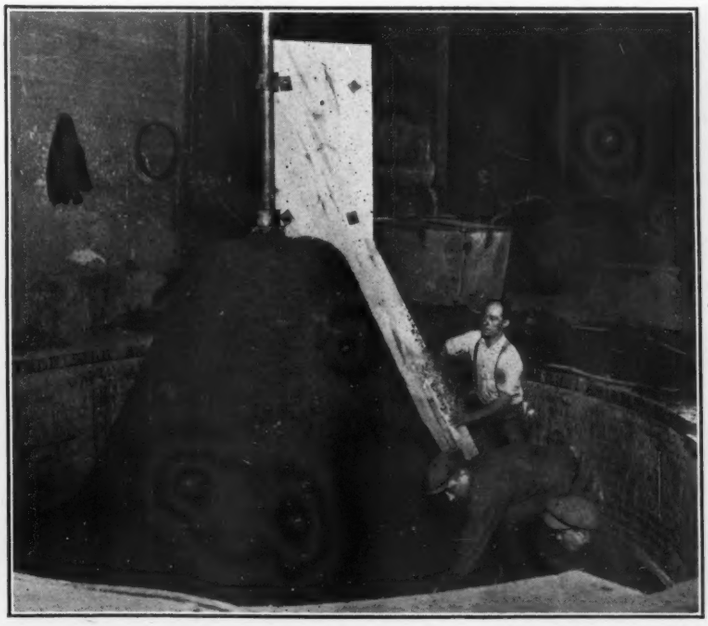
The core of a large casting is often composed of many units which must be assembled with great nicety.

One of our illustrations shows the very reverse of blowing the wash into the interstices of a mold: the photograph in question depicts the use of a compressed air siphon for the extraction of dust and dirt from narrow passages between the core units of a mold for a 50,000-pound runner for a water-turbine installation. Here, a stream of compressed air is so discharged as to induce a suction in a pipe extending at right angles down from the air nozzle, and the resultant partial vacuum suffices to withdrawn undesirable material that has fallen into crevices in the mold. A water wheel or runner of this sort calls for the exercise of a foundryman's highest skill. The numerous and curving blades of the turbine transform the energy in the moving water into power for the driving of a big surmounting dynamo; and, needless to remark, the vanes or blades must be true in their contours, comparatively thin, and properly surfaced so that only a minimum amount of finishing will be needed to fit them for their designed service.

Siphoning out the sand and dirt which has fallen between the cores of a water-wheel-runner mold in the making.

All that has been said in the foundry article in the preceding issue of the Magazine regarding the care that must be taken in lifting and in inverting the halves of a mold—especially the cope—applies with even greater force in a steel foundry where the castings are so much larger. To stiffen the mass of the sand, to add to the stability produced by thorough mechanical tamping, it is customary to reinforce the sand by inserting more or less numerous metal bars. For the sake of economy, these bars, which are not infrequently bent purposely or during the removal of a casting from the sand, are used over and over again; and this is rendered practicable at the Wheeling plant by an air-operated press or straightening machine. We have reproduced a photograph of this apparatus.

Assuming that the work has been correctly done up to the point of pouring the metal and of removing the castings from the enveloping sand, the successful running of a large steel foundry depends thereafter upon the rapidity and the manner in which the castings are cleaned and made acceptable to the customer. That is to say, the cores must be broken up and got out of the castings; excess metal in the form of fins, sprues, gates, etc., must be disposed of; and the external surfaces must be chipped and smoothed agreeably to specifications. Owing to the high temperature of the steel at the time of pouring as well as to the volume of the metal in a big casting, the sustained heat bakes the cores so that they are extremely hard and difficult to get rid of afterwards. At the Wheeling foundry, most of the core breaking is done by pneumatic chippers using steels of varying lengths agreeably to the position and the dimensions of the cores to be broken up.



Sweeping out the core of a mold for a large cinder ladle.

Take, for instance, the generator spider already referred to. Each half of the spider requires the steady work of four men for ten days to clear out the cores and to chip away undesirable surplus metal, and this, mark you, with pneumatic tools. It is impossible to tell how long it would take to do a similar job by hand; but it is safe to say that no task of this character would be essayed by a steel foundry if it lacked air-driven core breakers, chippers, etc. In other words, engineering progress, the production of immense and essential steel castings, would be hampered or halted but for these up-to-date efficient and labor-saving implements.

A gib crane equipped with a handy Imperial pneumatic hoist having a lifting capacity of 2,000 pounds.

The slag from both iron and steel furnaces is usually run into cinder ladles mounted on trucks which are drawn to a convenient dump where the trunnioned ladles are tilted and emptied. It is essential that the interior surfaces of the ladles shall be smooth, for otherwise the slag may chill in transit and adhere to the containing walls and refuse to drop out when the ladles are tipped. Therefore, the insides of these big cups must be first chipped and then ground to a suitable degree of smoothness. To so chip and grind a ladle, such as we show in the layout accompanying this article, calls for only two man-days of chipping and one man-day of grinding.

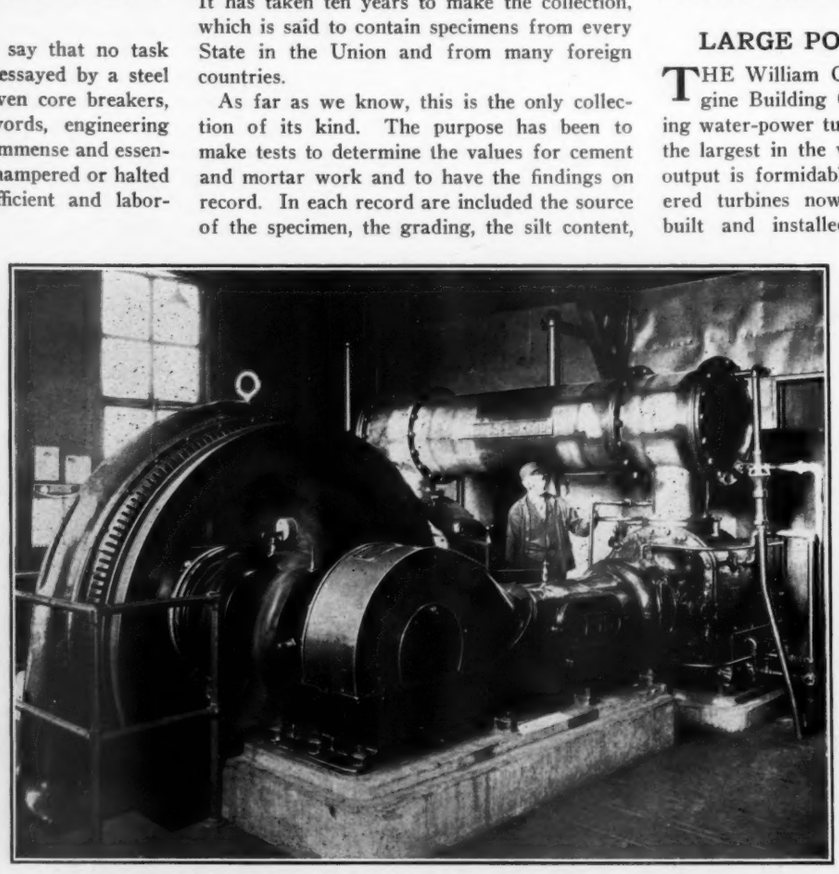
It is claimed that the Wheeling plant, because of its extensive employment of pneumatic chippers, gets a bigger tonnage of chipped metal per man than any other foundry in the country. Be this as it may, it is undeniably true that the foundry has scores of air-driven chippers at work, and considerable care is taken by the management of the tool room to keep the chippers fit for their rugged and trying tasks. Immediately after the chippers are turned into the tool room at the end of any period of service they are suspended in a tank filled with kerosene, and this oil effectually removes any dirt or grit which may have got into them. In this way, the wear and tear on the tools is minimized and the chippers are made ready for prompt re-issue.

Compressed air plays its recognized useful part in the core-making department of the foundry; compressed air operates hoists; it actuates the sand-blasting equipment; and it is widely employed for sweeping or dusting off cores, patterns, and molds at various stages of the work. In the associate pattern shop, air-driven gouges are used in rapidly getting rid of considerable masses of wood when blocking out the approximate forms of large patterns. Here, as elsewhere in the plant, time and labor are saved by recourse to compressed air.

"LIBRARY" OF SAND

IN THE Structural Materials Library of the Lewis Institute, Chicago, there is a special "library" consisting of 2,800 bottles of sand. It has taken ten years to make the collection, which is said to contain specimens from every State in the Union and from many foreign countries.

As far as we know, this is the only collection of its kind. The purpose has been to make tests to determine the values for cement and mortar work and to have the findings on record. In each record are included the source of the specimen, the grading, the silt content, and the results of calorimetric tests for organic impurities. In most cases, mortar and concrete tests have also been made.



One of the big compressors which furnishes operative air for the foundry. A PRE-2 machine having cylinders of 15¾ and 26 inches with an 18-inch stroke.

A new dry-dock is to be constructed at Naples, Italy, and, when completed, it will be the largest in the Mediterranean.

A pneumatic press which straightens out stiffening rods used in various parts of large molds.

LARGE POWER TURBINES

THE William Cramp & Sons Ship & Engine Building Company is now constructing water-power turbines which are said to be the largest in the world and whose aggregate output is formidable. The three highest-powered turbines now in operation were lately built and installed in the new Chippewa-Queenston station at Niagara Falls, and the Cramp Company is also placing in the Niagara Falls plant on the American side a 70,000-H.P. turbine while completing another in its shops. For the same powerhouse there are being made three hydraulic penstock valves, and these are also the largest in the world. Another contract calls for three 9,850-H.P. turbines, to operate under a head of 220 feet, for the Kentucky Hydro-Electric Company. In the San Francisco plant of the Pelton Company, owned by Cramp's, three 33,000-H.P. turbines for the Pitt River Station No. 3 of the Pacific Gas & Electric Company are under way.

Carrying a Foundation to Bedrock Under Trying Conditions

Some Unique Features Involved in Building a New Home for the Philadelphia Inquirer

By HARTFORD CURTIS

THAT OLD and dignified journal, the *Philadelphia Inquirer,* has outgrown the quarters it has long occupied and from which it has been issued daily for many years. It needs more room and better and more modern facilities for conducting its business, and will soon have both. Casting about for a type, the skyscraper idea appealed to the management; and the architects who were employed, Rankin, Kellogg, and Crane, have planned a beautiful structure—a skyscraper on the so-called American plan of architecture.

The new building will be approximately 400 feet long—extending all the way from Broad to Fifteenth Streets—and about 192 feet wide from Callowhill Street north to the old plant of the Baldwin Locomotive Works. Upon this area—having a ground floor space of an acre and three-quarters—will be erected what is claimed to be the largest newspaper office in the world. There will be nineteen stories beneath the enormous clock, which is to be surmounted by an ornate dome—the total height of the structure from sidewalk to pinnacle being 332 feet.

The building, however, will not retain the ground dimensions throughout its height. At the sixth floor it is set back and, likewise, at the thirteenth, the fifteenth, etc., as is the modern practice in the construction of towering edifices. This terrace-like style of architecture, topped with the artistic clock and dome, will present a pleasing spectacle to the eye in a part of the city where monotonous, unadorned brick walls prevail.

But what more particularly interests the readers of this Magazine is the fact that this enormous structure will have no cellar—as cellars go, for it is being constructed over one of the switching, delivery, loading and unloading yards of the Philadelphia & Reading Railroad which occupies the entire space with a network of tracks. The cellar, therefore, will be the railroad yard—the *Inquirer* section of the building beginning on the sidewalk level.

THERE is nothing especially new in sinking boiler-iron cylinders to solid rock and in filling them with concrete in order to obtain a good foundation upon which to build a heavy structure.

There is nothing especially new in using compressed air and all manner of pneumatic tools in digging disintegrated rock out of 6-foot cylinders, 30 feet under ground, or in drilling recesses in retaining walls to admit supporting columns.

But it is something of a departure to build a 19-story skyscraper covering an acre and three-quarters of floor area over dozens of busy railroad tracks, and to sink the supporting foundation cylinders and piers between tracks without interfering with traffic.

In the accompanying article the author tells how this is now being done in building the new home for the Philadelphia Inquirer amid the tracks of the Philadelphia & Reading Railroad; how the existing railroad yard will actually be located in the cellar of the new structure; and how compressed air is helping materially in the big undertaking.

In consequence, the foundation work involves some difficulties, as the piers that are to sustain the weight of the structure must be placed with due regard to the track system—which cannot be materially altered; and the work must be executed in such a manner as not to interfere with the free use of the tracks.

The foundation adopted is so designed that the load will be sustained upon concrete piers resting on the solid rock which underlies the entire site. But as the solid ledge is overlaid by many feet of clay and decomposed rock which is anything but solid, the architects, in order to penetrate this stratum, have decided upon the Gow system of so-called "caisson piles." The general contractors, Roydhouse Arey Company, operating through Charles R. Gow Company, contractors of Boston, are now engaged in sinking the foundation pits to solid rock and in filling the caissons with concrete. There are 150 of these caissons; and the spans between them vary from 16 to 32½ feet—the arrangement being dictated largely by the positions of the tracks.

The Gow system consists in sinking circular casings of boiler iron and in filling them with concrete. If a considerable depth is to be reached, a casing of smaller diameter is first sunk, and this is followed by one of a sufficiently larger diameter to slip over the first, and so on—the diameter of the top casing being a good deal larger than that of the bottom one. This difference in diameter depends upon the number of lengths or sections used.

In the erection of the *Inquirer* building, the casings are of $^{3}/_{16}$-inch boiler iron and have an average diameter of about 6 feet. The disin-

Numerous cylinders are being sunk to bedrock through overlying soil in order to insure firm footings for the foundation "caisson piles."

Careful drilling and blasting are required in breaking into retaining walls to provide space for the sinking of foundation cylinders.

This busy freight yard will occupy the cellar of the towering structure which is to be reared above it and yet have its footing on underlying rock.

tegrated rock, mixed with clay, begins almost immediately under the yard level, and it becomes harder as lower depths are reached. Casings are inserted as soon as the workmen get down to a depth which renders it necessary to confine the excavations to narrow limits. Hard rock is found at depths ranging from 20 to 35 feet below the yard surface, but the average depth is about 22 feet.

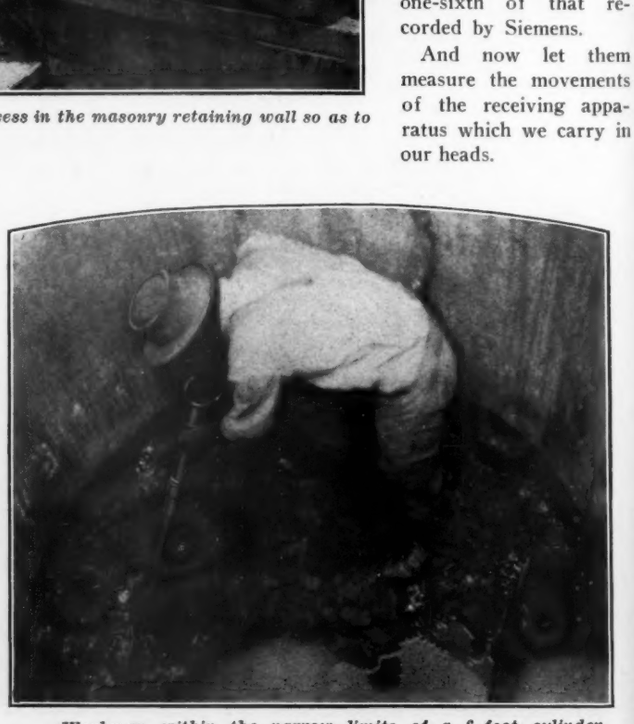
The disintegrated rock is hard enough so that pneumatic tools can be used on the job to great advantage. Not only are they more economical in breaking up the soft rock, but within the narrow limits of a 6-foot cylinder a workman has little chance to swing a pick. At first, No. 56 H clay diggers with spade attachments are employed, but, as the rock becomes harder, picks are inserted in place of the spades. Usually there is room for but one man to work in a single pit. He loosens the rock with his pneumatic tool and, when a sufficient amount has been so detached, shovels it into a bucket to be hand-hoisted out by means of a portable, 3-legged derrick. The removal of the dirt is necessarily slow, owing to the closely confined space in which the laborer must toil—in fact it is so slow that the contractor informed the writer that he proposed installing air hoists to speed up operations.

The "Jackhamer" drilling holes to form a recess in the masonry retaining wall so as to admit a foundation column.

Water is encountered in many of the pits, and this is disposed of by an ordinary, portable, gas-engine pump of the Novo type. There are six or seven of these on the job; and all air is supplied by two portable compressors—one 8x8-inch Type Fourteen and one 9x8-inch Type Twenty. Operative air serves the contractor in a variety of ways.

On the Callowhill side of the building is a high retaining wall. In order to obtain the desired width it is necessary to dig cylinder pits partly underneath this wall and to blast out enough of it to admit the casings. In this operation, occurring at a dozen or more places, "Jackhamers" are used for drilling—the holes being lightly loaded with powder to avoid damaging the wall. At each of these two points, also in order to provide for the full length of span, it will be necessary to drill narrow, vertical recesses, each having a depth of from two to five inches, extending from the bottom to the top of the wall so as to admit the supporting columns. This is a ticklish undertaking—and one to be performed economically only by an air-driven tool.

The foundation work has progressed far enough, that is, enough pits have been dug and cylinders sunk to give a clear conception of the magnitude of the work involved. The photographs give an idea of the progress made and of what still remains to be done before the *Philadelphia Inquirer* will be able to abandon its old home.



Workman within the narrow limits of a 6-foot cylinder loosening disintegrated rock by means of the pneumatic clay digger.

FEATS OF THE MICROMETER

IT IS not easy to appreciate, even when we are told, how small is the current required to produce audible sounds in a telephone receiver, and how minute is the actual movement of the diaphragm. This movement for a just-audible sound was measured, in 1905, by P. E. Shaw, who found it to be about one-thirty-fifth part of a millionth of an inch. say 0.000,000,028 inch.

As to the current, Werner Siemens found that with a particular Bell telephone the interruption of a current of one-fifty-thousandth of a milliampere, when passed through the coils, gave a sound just audible; and Professor Fleming has stated that some modern receivers will make a sound at the starting or stopping of a current not more than one-sixth of that recorded by Siemens.

And now let them measure the movements of the receiving apparatus which we carry in our heads.

Oil-Engine-Driven Ferryboat of Exceptional Merits

The "Hudson-Athens" is a Fine Example of Progress in Marine Engineering and a Happy Solution of a Transportation Problem

By ROBERT G. SKERRETT

ON THE historic Hudson, about 30 miles below Albany, are located on the west and the east banks of the river, respectively, the incorporated township of Athens and the city of Hudson—the first of 2,000 inhabitants and the latter boasting a population of 14,000. Hudson, so we are told, was at one time the third city in New York State; and, according to some writers, there it was that Hendrick Hudson ended his voyage northward in the *Half Moon* when he explored the waterway which now bears his name. Both Athens and Hudson lie at points on much traveled state highways: the road through Athens running westward to the beautiful Catskill Mountains while from Hudson the no less lovely Berkshires can be reached by a drive of about 30 miles. As might be expected, many thousands of tourists journey through these river towns every year.

In recent years, Athens and Hudson have felt the influence of the steadily increasing tide of motor traffic; and at every turn it is apparent that the motor car and the motorist have stimulated business in the hotels, the shops, and the service stations which have been called into being to provide for the particular needs of the self-propelled vehicle. But these conveniences for the transient would probably fall far short of giving satisfaction if the two towns were not brought closer together, made more accessible, by an up-to-date ferryboat. The enterprise of the people responsible for this craft sets an example which the citizens of other communities, somewhat similarly situated, might follow to advantage.

The automobilist, taking him as you find him generally, is an impatient body—speeding over the country's highways has made him insistent upon dispatch and prompt service in numerous directions. He is apt to shun a town where delays are common or where the merchants and contributive activities are slow and little disposed to lend their aid to haste in getting onward. Inadequate ferry facilities have done much towards hurting a place in the opinion of motorists; and, on the other hand, adequate ferriage is one sure way to attract motor traffic and to win a compensating increase in local business.

NAVIGABLE bridges that can be used to close hampering water gaps are needed at hundreds of points throughout the length and the breadth of this land of ours. This state of affairs is not new; but the demand for better service has latterly been emphasized by the automobile and the motor truck.

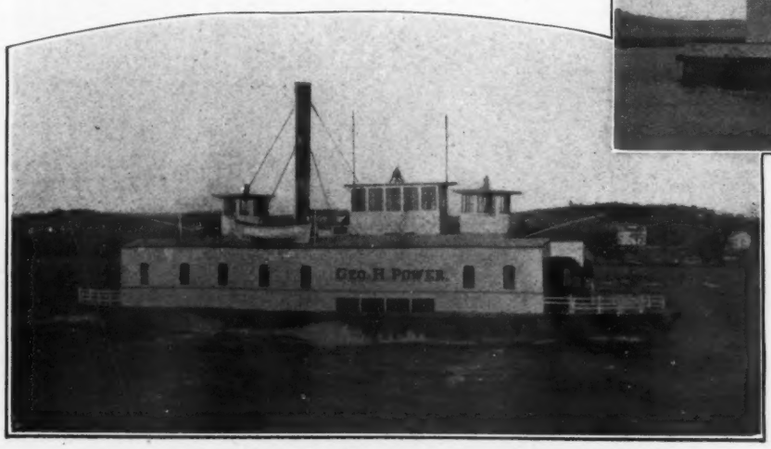
Power-driven vehicles have profoundly altered circumstances, because their speed tends to concentrate them at focal points of traffic and to lead to congestion unless more numerous or more efficient ferrying craft be available.

To deal effectually with this situation and to do so at a reasonable outlay is a very pressing problem. In the present article we tell how admirably the needs of two neighboring river towns have been met in this respect.

The responsible officials of the Hudson and Athens Ferry Company were fully alive to the trend of events when they decided, more than two years ago, to dispose of their old steam-driven, side-wheel ferryboat *George H. Power* and to put upon the route a thoroughly modern craft capable of taking care of both the passenger and the augmenting vehicular traffic. It is interesting to recall here that the service is maintained agreeably to separate franchises granted by each of the communities concerned. This situation has had its drawbacks in the past, and led to an amusing but momentary embarrassment about 54 years ago. In 1858, the *J. T. Waterman* was put on the line, and for a decade that unpretentious vessel journeyed in a leisurely fashion to and fro between Hudson and Athens, and answered fairly well in the days when the ox cart and the horse-drawn vehicle were the accepted order of conveyance.

But in 1869, one of the towns protested and demanded an improvement—in fact, insisted

The "Hudson-Athens" is not only a bigger and better boat but a cheaper one to operate.



The old "George H. Power" which is now operating on Lake Champlain.

that the route be equipped with a larger boat, one two feet wider and ten feet longer than the *J. T. Waterman*. There must have been a "sea lawyer" somewhere in the background, because it would have been a comparatively easy matter to lengthen the old ferry, but she could not have been broadened without entirely rebuilding her. As a result, a new hull of the prescribed dimensions was constructed, and into it was put the *Waterman's* engine. This

craft was named the *George W. Power,* and served the neighboring communities until she was displaced by the present oil-engine-driven, propeller ferry *Hudson-Athens.*

The change from steam propulsion to oil-engine drive involved a radical departure, and the management of the Hudson and Athens Ferry Company was little disposed to make such an innovation until thoroughly satisfied that the substitution was in the direction of economy and increased efficiency. However, after carefully studying the conditions of service and the advantages claimed for the internal combustion engine, the responsible officers decided to equip the boat to be built with a Price-Rathbun 4-cycle marine oil engine capable of developing 220 brake-horse-power; and the contract for this prime mover was awarded the Ingersoll-Rand Company.

This view of the ferryboat gives a good idea of the commodiousness of her main deck, which is capable of accommodating fully 30 motor vehicles.

Before entering upon further details of this engine and its associate auxiliary equipment, it might be well to give the general characteristics of the boat and also to outline the nature of the route traversed in linking Hudson and Athens. The *Hudson-Athens* has an overall length of 115 feet; a waterline length of 98 feet; a maximum beam, over the guards, of 44 feet; and a loaded draft of 7½ feet. The run, from slip to slip, traces a U-shaped course which doubles around the south end of flats lying in the middle of the river, and the distance covered is approximately 1¼ miles. Because of the foregoing circumstances and the rather frequent strong sweep of the tidal currents, the ferry must be handled with considerable skill and her movements and speed must be under ready control. In other words, the craft must be able to go ahead and to back quickly and to gather headway promptly.

Anyone familiar with the operation of ferryboats in comparatively restricted or much traversed waters will readily appreciate why the Hudson and Athens Ferry Company, used to the well-known flexibility of steam drive, should have hesitated for a while to adopt an oil engine which is not commonly supposed to have the same maneuvering range. This point should be kept in mind because it will help to a better understanding of the progress in engineering that is represented by the prime mover with which the *Hudson-Athens* is equipped . As far as our knowledge goes, this double-ended ferry is the first of her kind in service today to be equipped with direct-connected, direct-reversible oil-engine drive; and her performance during two operating seasons proves the entire practicability of this form of propulsion.

The *Hudson-Athens* was designed by Eads Johnson, Inc., naval architects, of New York City; and the main deck space is allotted to vehicles—the four runways being capable of accommodating about 30 automobiles of the usual assorted sizes. Passengers are carried on the upper deck, and the cabin there is reached by a stairway at each end of the central casing. In busy hours, the boat can take care easily and comfortably of 270 persons. During the open season, the ferry makes 25 round trips every weekday and 23 round trips on Sunday; and during the two

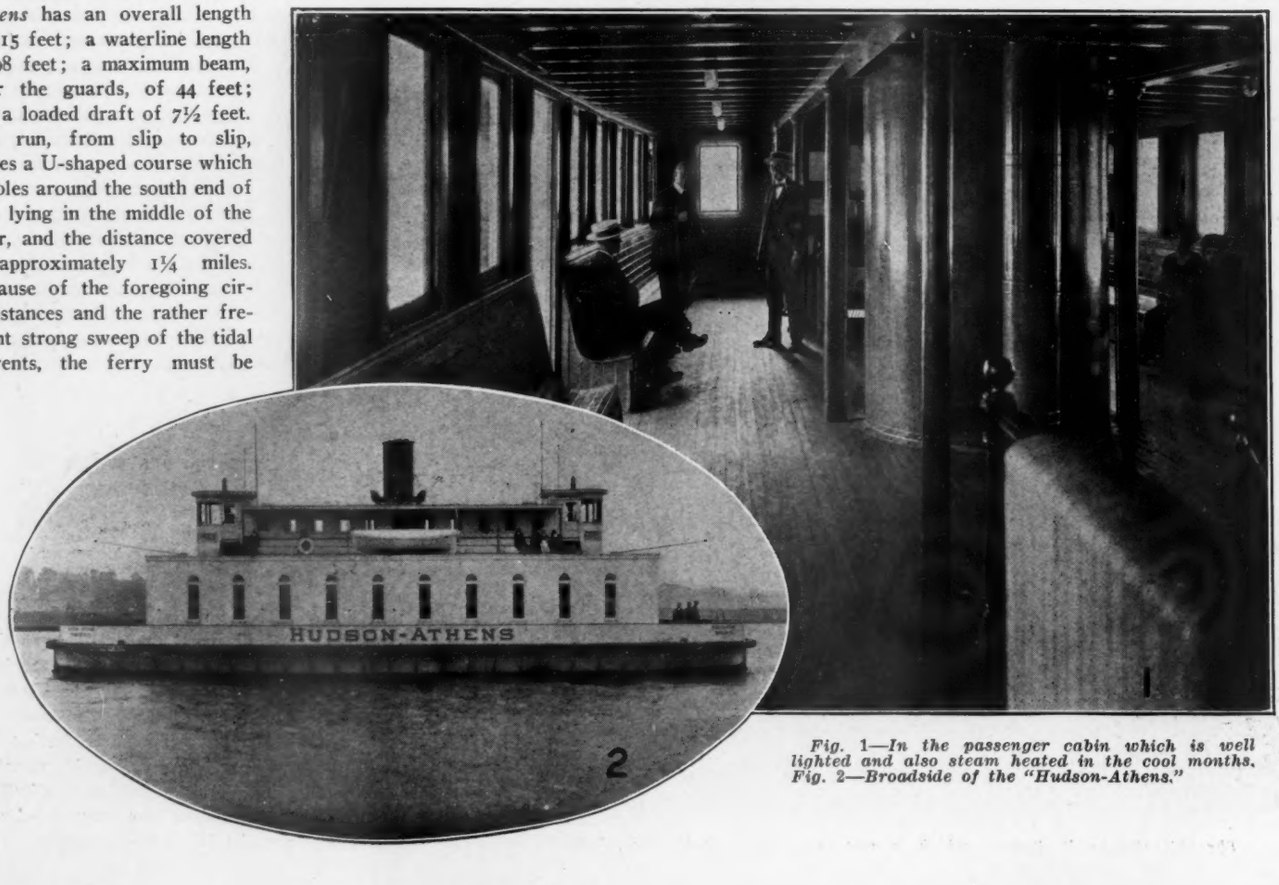


Fig. 1—In the passenger cabin which is well lighted and also steam heated in the cool months. Fig. 2—Broadside of the "Hudson-Athens."

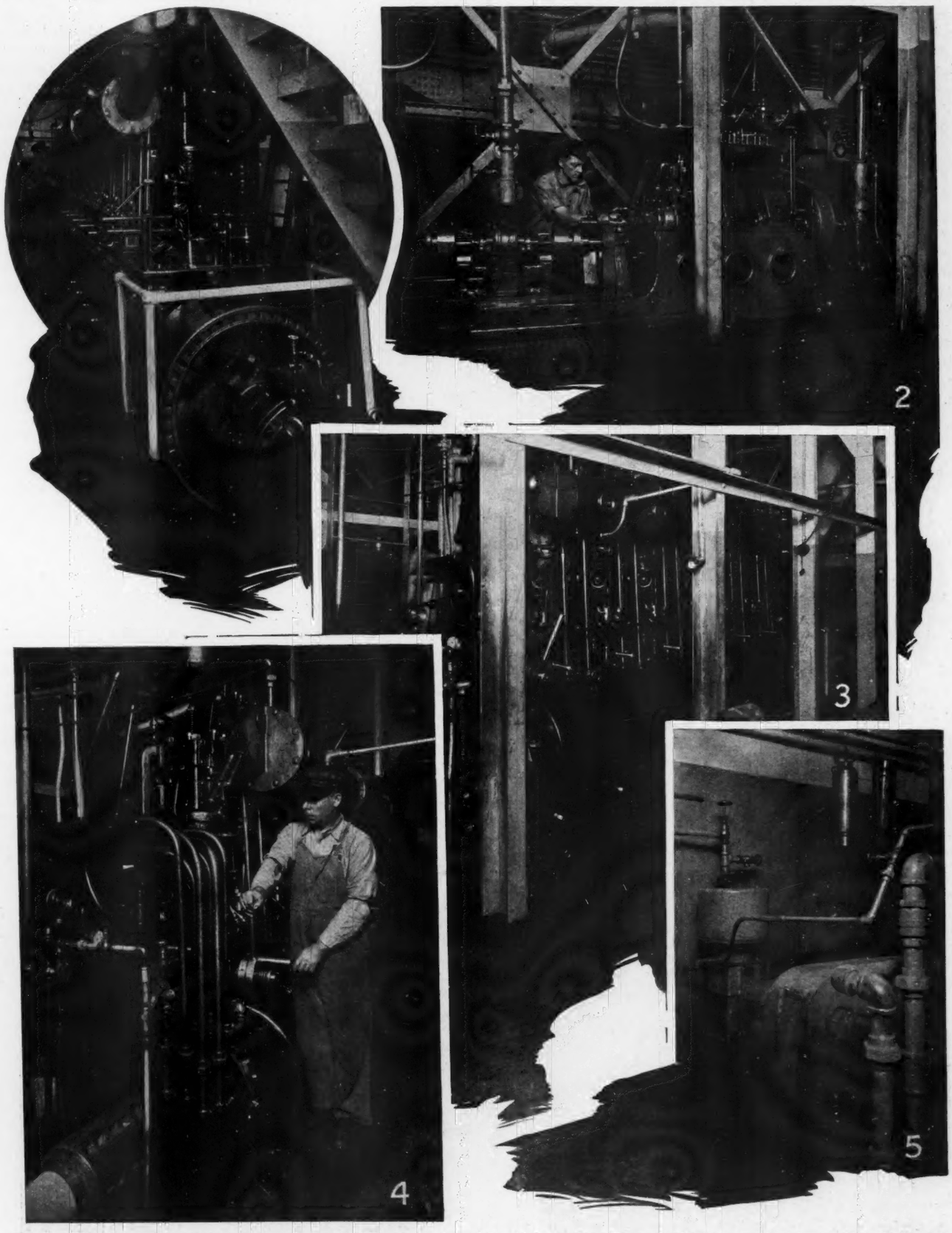


Fig. 1—Direct-connected, direct-reversible, Price-Rathbun oil engine which develops 220 brake horse-power. Fig. 2—The auxiliary power unit is a 2-cylinder, 15-H.P. Mianus engine. Fig. 3—Owing to the compactness of the prime mover the engine-room seems exceptionally roomy. Fig. 4—By moving a single lever the engineer can exercise complete control of all maneuvers of the engine. Fig. 5—The small 2-stage Ingersoll-Rand Type 15 compressor which furnishes maneuvering air for the main oil engine.

years the boat has been in service she has maintained her schedule with the exception of one trip, and that failure was in no wise attributable to her main engine.

The hull and the center casing are of steel, and these were constructed by the Anchor Shipbuilding Company, Washburn, Wis., where the vessel was launched July 4, 1921. In order to make it possible for her to pass under the bridges spanning the New York State Barge Canal, the center casing was not erected until the craft reached Hudson. During the 2,000-mile voyage eastward from Washburn, the crew lived in temporary quarters built for them on the main deck; and the boat was also navigated from a steering station provided for the time being on the same deck. The *Hudson-Athens* covered the whole distance under her own power; and notwithstanding the exacting demands in the way of maneuvering and of changing speeds—especially on entering and leaving locks and when traveling slowly through some sections of the canal—she accomplished the journey without mishap of any sort.

After reaching Hudson, the center casing was erected; the superstructure and the cabin built; and other finishing work done by carpenters, etc., drawn from a local shipyard. But, owing to various delays in carrying out these jobs, ice several inches thick formed on the river before the ferry was ready for service, and, therefore, the management decided not to put her on the run until the spring of 1922. In passing, it might be remarked that an operating season covers a period of from 10 to 10½ months—depending upon the severity of the winter and the thickness of the ice in the river. While the *Hudson-Athens* has broken her way on occasions through ice four or five inches thick, still the company is not required to keep her in commission when ice interferes with traffic.

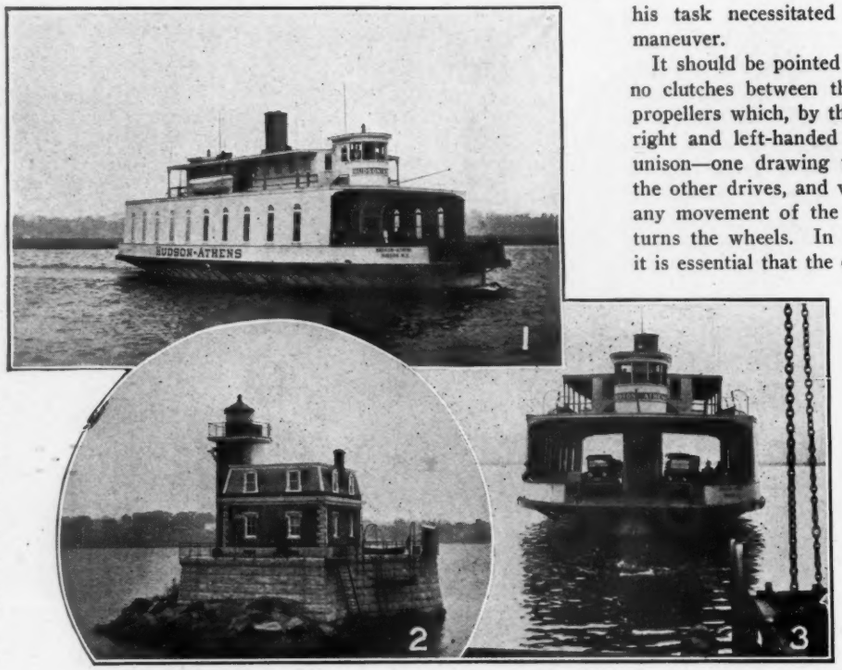


Fig. 1—The "Hudson-Athens" in midstream. Fig. 2—Hudson Light at the southern tip of the flats. Fig. 3—The ferry heading in for her slip on the Hudson side of the river.

Now let us consider the ferry's main 4-cycle power unit. This prime mover is of six cylinders having a uniform bore of eleven inches and a stroke of fifteen inches. When making 300 revolutions a minute, the engine develops 220 brake horse-power. On entering a slip, the engine can be slowed down to 40 R.P.M. While no record has been kept of the number of engine maneuvers required on each trip, it is believed that they average not less than eight, and this would mean, in the course of ten months, let us say, a total of 120,000 maneuvers. Plainly, an engine, to satisfy service demands of this nature, must have a dependable and, withal, a decidedly simple reversing mechanism—otherwise there would be trouble and probably breakdowns. Not only that, but the man at the throttle would be worn out if his task necessitated several acts at each maneuver.

It should be pointed out here that there are no clutches between the main engine and the propellers which, by the way, are, respectively, right and left-handed screws that operate in unison—one drawing the boat forward while the other drives, and vice versa. Accordingly, any movement of the direct-connected engine turns the wheels. In the absence of clutches, it is essential that the engine, itself, be capable of speedy reversing; and the fact that the engine in question meets this requirement fully brings us to one of the most commendable of its features.

The chief engineer of the *Hudson-Athens*, Mr. William H. Hoffman, has thus described the reversing gear employed. "The opening and the closing of the intake and the exhaust valves are symmetrical with respect to the top and the bottom dead centers, and the number of degrees the valves are held open is identical. When the direction of rotation of the engine is reversed, the functions of the exhaust and the inlet valves are automatically interchanged. Since there is no camshaft to be rotated, the operation of reversing consists simply in bringing the engine to a stop and then in moving the air-starting cam through an arc of 60 degrees—this maneuver serving to admit air to that particular cylinder whose crank is at the moment in a position to rotate the engine in the opposite direction." It would be hard to imagine anything less complicated. This novel system has splendidly demonstrated the engineering soundness of its design.

The engine can be stopped, started in either direction, and its speed altered by the movement of a single lever, which is so placed in relation to the centerline of the craft that its handle always points in the direction of travel if the boat is underway. The engineer's task is, therefore, a very light one; and he exercises complete command over his

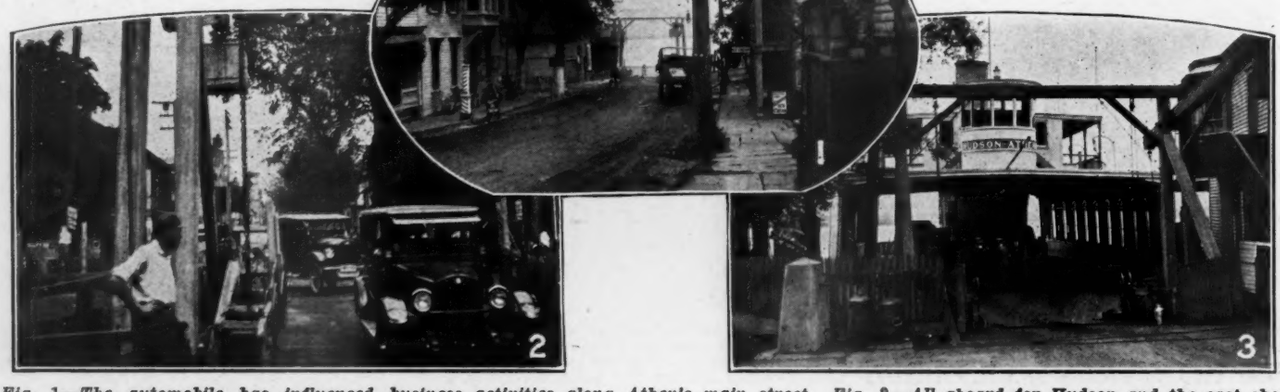
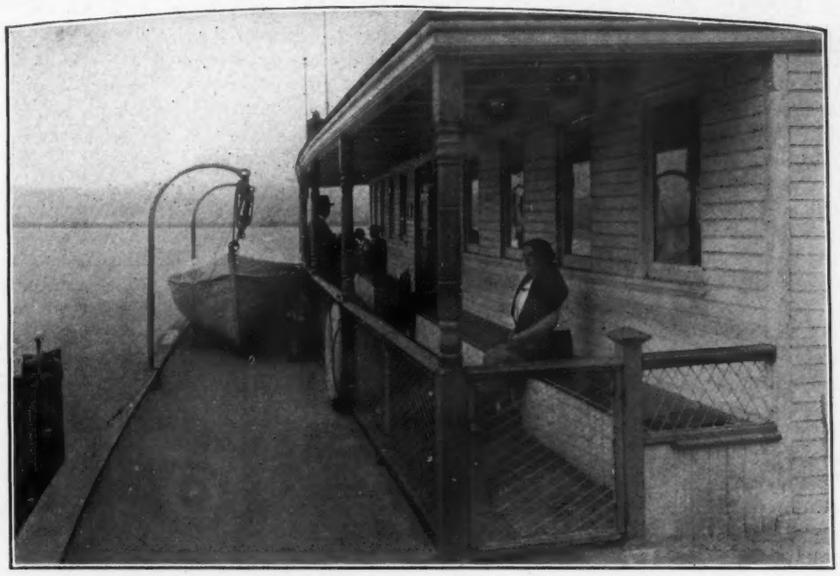


Fig. 1—The automobile has influenced business activities along Athen's main street. Fig. 2—All aboard for Hudson and the east shore of the river. Fig. 3—The ferry in her slip at Hudson.

charge with a minimum of effort and with a certainty of proper response.

The question will naturally arise in the minds of many that are familiar with oil engines: Isn't such a system of reversing apt to prove harmful to the exhaust and the intake valves? Mr. Hoffman declares the results to be quite the opposite. He claims that the intermittent cooling and heating of the valves actually increase their service life; and he bases his conclusion upon the condition of the engine's valves after the prime mover had performed for twenty months and covered substantially 55,000 engine-miles. During that interval it was necessary to replace only one valve, and that valve, had time permitted, could readily have been made fit for use again.



Passenger accommodations outside on the upper deck. The trip is a picturesque one from shore to shore.

While it is the practice of the chief engineer of the *Hudson-Athens* to grind all valves at the end of an operating season, it is also his custom to grind them at least once during the active season. In this connection, he tells us: "The last cylinder on which we ground valves has made 10,000 miles—a record for oil engines, and upon opening up the cylinder in question we found the valves quite capable of doing an additional 1,000 miles just as they stood. I credit this remarkable performance to the fact that the exhaust valves are not run continuously at high temperatures."

For the sake of those who may be interested in engineering particulars, we might mention that the crank shaft extends at both ends of the engine and is connected to the intermediate shafting by means of muff couplings; and a decidedly unusual feature is the employment of a double Kingsbury thrust bearing at only one end of the prime mover. When the boat is moving in one direction the thrust is absorbed directly by this special bearing, but when the craft is traveling in the opposite direction the thrust is transmitted through the whole length of the crank shaft and is absorbed by that portion of the driving system. While this procedure differs radically from regular steam-engine practice, still the Ingersoll-Rand Company are satisfied that the departure is a technically correct one, and the results bear out their contention. That company argues that inasmuch as an oil-engine crank shaft is of so much larger diameter than that of a steam engine of similar power, and as the propeller thrust is small compared with the other stresses acting on it, there is, therefore, no warrant for installing an additional thrust bearing. As a matter of fact, no trouble of any kind has developed with the crank shaft since the ferry began its service, and no main or crank-pin bearing has been wiped. It is recognized, of course, that the extension of the crank shaft at both ends of the engine would be out of the question on a 2-cycle engine using crank-case compression, because it would be well-nigh impossible to keep the crank-case sufficiently tight.

Now, a few words descriptive of the auxiliaries. Circulating water for the engine is distributed by a 2-inch, bronze, Viking rotary pump; and compressed air for maneuvering the engine is provided by a 2-stage, Type 15, Ingersoll-Rand compressor of 4-inch stroke with cylinders having bores of 1⅞ and 4 inches. Both the circulating pump and the air compressor are carried by a common sub-base and are driven from the engine's intermediate shaft by sprocket wheels and silent chains. Air for starting the engine is stored in a steel tank 6 feet long and 30 inches in diameter. The quantity of air required for each maneuver is relatively trifling; and the receiver has proved of ample capacity to meet all demands.

A 2-cylinder, 15-H.P. Mianus engine forms an auxiliary power unit, and this engine drives at one end an Ingersoll-Rand emergency air compressor and at the other a Gould rotary pump for general service. There is also a 3½-kilowatt, 125-volt, direct-current generator which is driven from the flywheel of the Mianus engine by means of a belt. The generator supplies current for lighting. A small rotary pump, driven from the main shafting of the prime mover, furnishes water for sanitary purposes; and, if need be, this pump can take care of the engine's circulating water needs.

Fuel oil is carried in two cylindrical tanks located at the sides of the engine room, and each of these has a capacity of 1,000 gallons. The tanks are cross connected so that oil can be drawn from either or both or from one to the other to maintain the boat's trim.

Just what the *Hudson-Athens* represents in operative economy is brought out by the fact that a vessel of the same size but of the *George H. Power* type would burn from $40 to $50 worth of coal daily, while the new oil-engined ferry consumes daily but $8 worth of fuel.

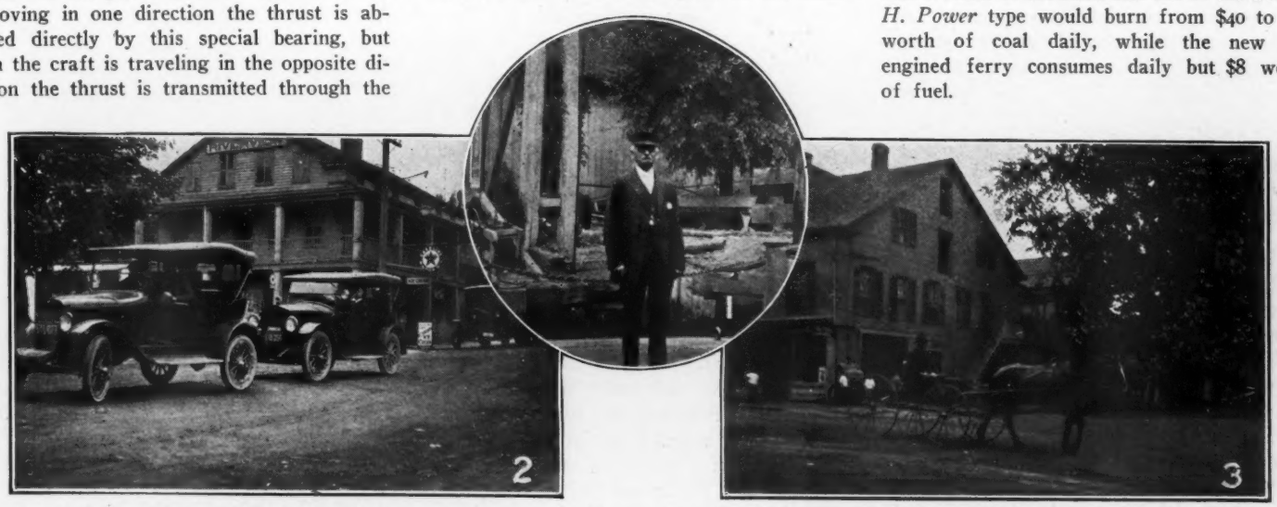


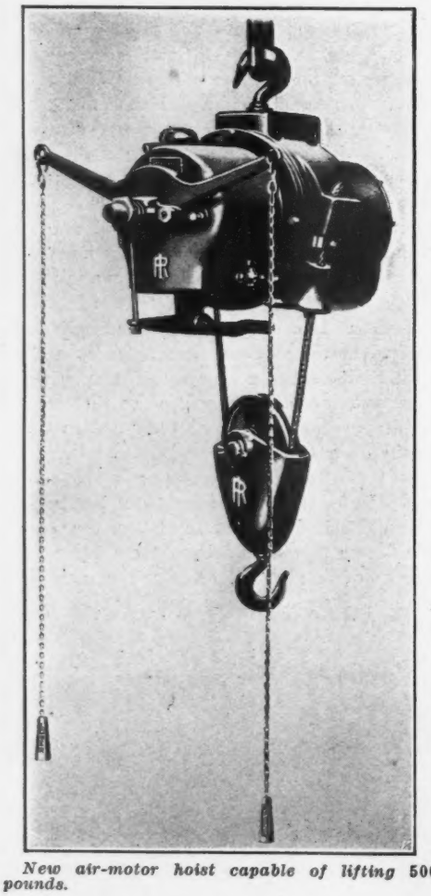
Fig. 1—Captain Frank Beardsley is proud of his new command. He has been on the route 28 years. Fig. 2—Motors lining up for the ferry in Athens. Fig. 3—The horse is still seen on Athens' main street.

SMALL AIR-MOTOR HOIST OF NEW DESIGN

A NEW STYLE, 500-pound-capacity air motor hoist of smaller and more compact construction than any hitherto available is now being offered to those industries in which rapid and economical lifting and handling of small loads, too heavy for one man to deal with, is desired. Its usefulness is largely in that field of service which has heretofore placed dependence for lifting upon chain, cylinder, or other types of hoisting equipment or upon manual labor.

Briefly, the manufacturers of this new hoist claim for it the following outstanding characteristics: an air motor hoist smaller in size than any previously built; low head room required because of compactness of design; relatively light weight; automatic brake which positively holds the load under all circumstances—even if the air supply be disconnected or fail; and a graduated throttle which permits a very close regulation of both the lifting and the lowering speeds.

It should be noted that this new hoist is entirely distinct from direct-acting cylinder hoists and lifts in that it is provided with a high-powered and efficient air motor which is geared



New air-motor hoist capable of lifting 500 pounds.

through a mechanical train to a hoisting drum. The motor has three cylinders, is perfectly balanced, and operates in either direction without vibration at any speed or load within the rated capacity of the machine.

The motor and the gears are both enclosed; and thorough lubrication of all parts is insured —the motor operating in a bath of oil while the gears turn in a heavy grease. Oil passages lead to all bearings; and ball bearings or bronze bushings are provided at all points where service experience has proved that they add to the efficiency or to the life of the hoist.

A roller-bearing, mono-rail trolley can be furnished in place of the top hook; and this trolley mounting considerably reduces the head room necessary for the installation. Further, because of its rigidity, which enables an operator to easily start the loaded hoist along the runway, such a mounting proves more satisfactory than the method of hooking the hoist into a separate trolley unit.

The automatic brake with which the hoist is equipped is a new and valuable feature, as it holds the load at any desired position for any length of time regardless of air pressure. The brake consists of a disk, attached to the motor shaft, and of a brake plunger with a friction face, which latter is held in contact with the disk by springs whenever the hoist is not operating, that is, whenever the air supply to the motor is cut off either by throttling or otherwise. As the brake acts automatically it requires no attention from the operator.

The throttle graduation, which is said to be very fine, insures instant and complete control of the hoist at any speed and, therefore, contributes to excellence of performance. A safety stop lever is also provided, and it closes the throttle and stops the motor whenever the load, by chance, is raised the full extent of the lift, in other words, to the top of the hoist.

For foundry work this hoist is claimed to be unsurpassed because of its freedom from vibration and its nicety of control. Wherever lifting is done indoors or outdoors—where the apparatus may be exposed to all kinds of weather, this hoist operates with uniform satisfaction and responds to the control of any one familiar with it. Hot, dusty, steaming, smoky, or acid-laden air does not affect it adversely.

The essential details of this air motor hoist, which is manufactured by the Ingersoll-Rand Company and is known as Size A, are as follows:

Capacity	500 pounds
Lift per minute at 80 pounds air pressure	50 feet
Maximum lift	15 feet
Size and length of wire rope	¼ inch x 35 feet
Net weight	150 pounds
Operating air pressures	60 to 100 pounds

FORD TO BUILD THOUSANDS OF CEMENT HOMES

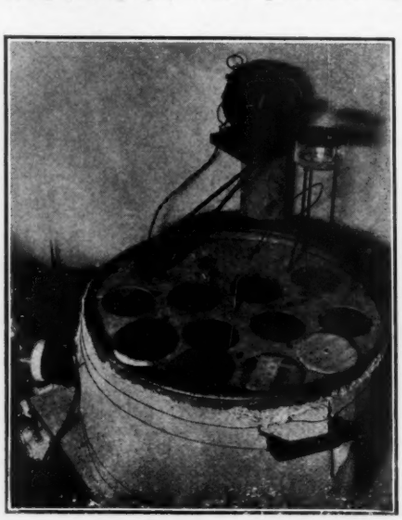
HENRY FORD announces that it is planned to erect 30,000 houses on a 5,000-acre tract of land south of the Dearborn plant of the Ford Motor Company. They are to be constructed of cement, according to a plan perfected by Thomas A. Edison.

The plans call for the pouring of the cement into set forms; and these molds can then be arranged into twelve different types of homes. The lumber is to be obtained from short pieces of timber usually allowed to go to waste; and the houses will be sold to any person who desires to buy, and at a price, so it is said, close to cost.

MAKING SURE OF WARM BLANKETS

MEANS have been devised by the Textile Section of the United States Bureau of Standards which make it possible to ascertain the heat-transmitting and the air-excluding properties of different kinds of blankets. A metal cylinder, eight inches in diameter, is employed to determine the amount of air that will penetrate a blanket. For the purpose of the test, the blanket is stretched tightly over the head of the cylinder; and the volume of air, under pressure, that leaks through the fabric is measured by a meter.

The apparatus that gages the moisture-absorbing properties, as shown in the accompanying photograph, is more pretentious than



The apparatus which tests the moisture-absorbing nature of a blanket.

the foregoing one. Outwardly resembling a barrel, the device is really a metal pan in the top of which are eleven holes, each holding a glass beaker. Heat, applied within the pan, evaporates the water put into the glasses; and the amount of vapor escaping measures the moisture-absorbing property of the piece of cloth stretched across the top.

The capacity of a blanket to transmit warmth is determined by stretching a sample of the fabric over an electrically heated metal surface, which is maintained at the same temperature as that of the normal human body. The heat radiating from the top of the material is then measured by electrical thermometers. The object of these tests is to standardize the materials so that the manufacturers of blankets may have definite specifications for their guidance. The ultimate consumer is interested in this because it is his comfort that is at stake.

An important outcrop of silver-lead ore has been discovered in Northern Queensland, Australia, about 26 miles north of Chillagoe in the vicinity of Big Watson River. The outcrop is said to be approximately three-quarter mile in length; and is in contact with a porphyry formation. Ten samples taken from places about 100 feet apart averaged from 50 to 70 ounces of silver and 50 per cent. of lead.

Portable Compressors Prove Their Worth on Wind River Canyon Road

By A. S. TAYLOR

"WYOMING will come into her own when her transportation facilities are in keeping with her natural and her industrial wealth." Such was the summing up of the state's most pressing need as recently outlined by a student of Wyoming's economic situation. This presentation of the state's predicament is not news to its energetic populace; and the following article shows how willing the citizenry are to pay liberally in order that they may have highways capable of giving the required traffic relief.

For the sake of those unfamiliar with the outstanding physical and industrial characteristics of Wyoming, it might be mentioned here that the state has an area of 97,914 square miles; and three years ago the population stood at 194,402. Despite the fact that the region as a whole is comparatively thinly settled, still in 1920 there were 1,200,000 acres of land under irrigation; and, counting the irrigation projects being pushed to completion, there will soon be available a total of 2,700,000 acres of farmland. According to the latest census figures, Wyoming produced crops in 1920 to the value of $50,000,000—the leading crop being alfalfa hay. Stock raising is the state's most important industry, and the wool clip from her flocks of sheep has amounted to an aggregate of 33,000,000 pounds in a single year.

The mineral resources of Wyoming are vast and in keeping with the natural riches similarly located in the other and neighboring mountainous states. To a considerable extent these deposits await commensurate development. Even so, during the twelvemonth of 1920, no fewer than 8,928,000 tons of coal were mined. Her stores of petroleum are known to be large; and gold, silver, platinum, and all the base minerals abound. But, as if to keep these treasures from distribution, mountain ranges hem in wide areas that are susceptible of producing an enormous income, and the wide-awake people of the state are now thoroughly determined to overcome this handicap by constructing suitable modern highways.

One outstanding example of this movement is the so-called Wind River Canyon road—an undertaking a trifle less than 21 miles in length that is being advanced through very rugged country which necessitates the excavation of great quantities of rock. The purpose of the work is to open up to ready access and exit the now comparatively isolated but intensely productive Big Horn Basin. This region, lying contiguous to the southern boundary of the State of Montana, is hemmed in on the west, the south, and the east by towering mountain ranges which are well-nigh impassable save during the summer season, and even then the existing roads are negotiated with more or less difficulty—light motor cars being the only self-propelled vehicles that can traverse them.

Nature, however, has pointed to a solution

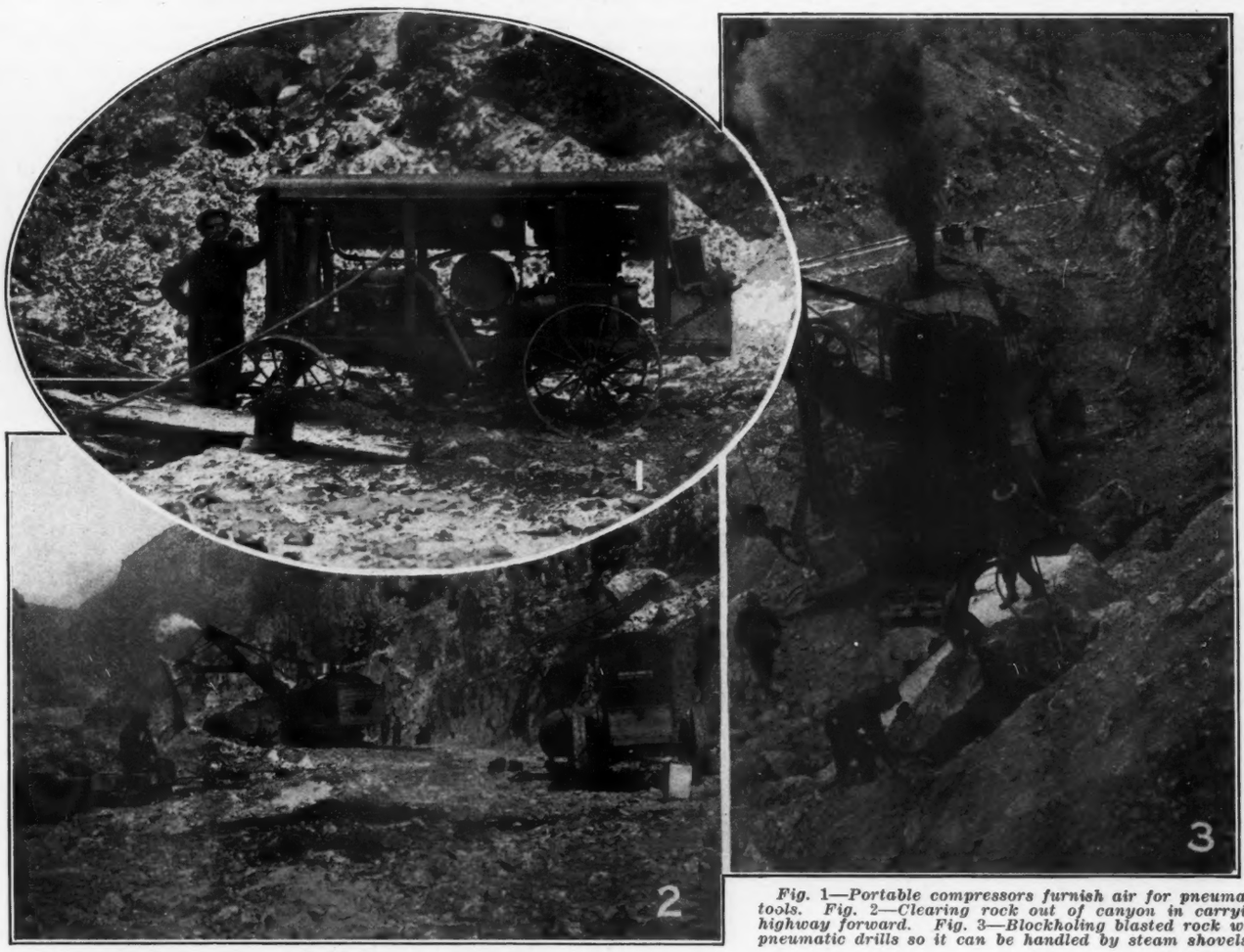


Fig. 1—Portable compressors furnish air for pneumatic tools. Fig. 2—Clearing rock out of canyon in carrying highway forward. Fig. 3—Blockholing blasted rock with pneumatic drills so it can be handled by steam shovels.

of the problem—this is by way of a deep, narrow canyon through which the Wind River traces a part of its course before merging with the Big Horn River. This canyon taps the Big Horn Basin at its southern limits and offers a low-grade outlet and a line along which a highway can be built which will sidestep the precipitous and at times hazardous road that has hitherto been the only means of transportation over the mountains.

Before starting work upon this project, the Wyoming State Highway Department completed a 28-mile survey which called for an outlay of nearly $7,500; and, because the river when frozen gave access to certain essential points, most of the surveying was done in the wintertime when the temperature, for weeks running, ranged around ten degrees below zero. The cost per mile of the road will vary from $13,965 to as much as $97,045, and a stretch of 9.4 miles will necessitate an average expenditure of $24,850 a mile. Considering the population of the state and the relatively moderate amount of taxable property, the money to be spent on this single, short highway is very suggestive and likewise indicative of the determination of the state to overcome or neutralize natural handicaps of staggering proportions.

The United States Bureau of Public Roads has imposed an acceptable limit of a 7 per cent. maximum grade, even in mountainous districts, and the Wyoming State Highway Department has recognized the wisdom of this course and adopted it. The state authorities, however, have gone somewhat further, and their attitude is that if a road is worth building at all it should be properly built no matter what the cost. In this spirit they have undertaken the construction of the Wind River Canyon project; and, notwithstanding the difficulties involved, the final location of the route calls for a maximum gradient not exceeding 5.6 per cent., a maximum curvature having a radius of 200 feet, and a roadbed 20 feet wide supplemented by a 3-foot ditch in cuts.

Owing to the diversity of physical features along the route, the Wind River Canyon project is divided into four construction sections, namely, Sections A, B, C, and D—beginning at the southern end of the undertaking. The new road leaves the old road at a point about ten miles north of Shoshone and follows a northwesterly direction until it reaches the river—from there on running along the stream for substantially the rest of the way. Section A is 7.50 miles long and links the old road with the canyon; and it is estimated that this stretch will involve an outlay of $106,000. Section B has a length of 1.95 miles, and it is expected that its completion will entail an expenditure of substantially $189,240. In prosecuting this part of the job, the contractor has to remove 84,000 cubic yards of material and drive three tunnels through rock for a combined distance of 842 feet. The tunnels pass through black diorite; and they are 14 feet high and 18 feet in width.

Section C, which is 9.4 miles long, traces its way along that part of the canyon where the principal materials encountered are sandstone and limestone talus overlying an aggregation of massive boulders. At points, for short stretches, the road has to be cut out of the face of nearly vertical cliffs. All told, Section C will necessitate the removal of a little less than 303,000 cubic yards of material; and the road, exclusive of surfacing and a guard rail, will cost well-nigh $234,000. The last section, that is, D, is 2 miles long and presents but little difficulty to the roadbuilder—the material to be disposed of being for the most part only earth. The Utah Construction Company, of Ogden, Utah, is the general contractor for the job.

Compressed air for the operation of pneumatic drills in Section B, where the tunnels are, is supplied by compressors located in the canyon and drawing motive current from the nearby plant of the Wyoming Power Company. An air line was installed which reached from end to end of this section. Most of the drilling was done at night and the mucking followed during the daytime; and the drills have been kept fit for their task by means of machine sharpeners.

The actual work in Section C has been in the hands of the Christensen Construction Company, and has necessitated cutting through talus and rock in the open. Operations there would have presented grave obstacles had the contractor not been able to call to his aid mobile power plants in the shape of three portable compressors—two 8x8-inch Type Fourteen machines and one 6x6-inch Type Fourteen outfit. These portables, which are supplying air to a group of "Jackhamers," have made it practicable to place the power plants close to their respective jobs and to move them along as the work advanced.

Broadly stated, the task has in the main consisted of getting rid of the talus and the cliff sections by benching and of the boulders by blockholing them so that they could be broken up into pieces that could be handled by the steam shovels. The boulders have varied in volume from 20 to 40 cubic yards.

The calcite crystals in the limestone have made the boulders troublesome to drill; but when blockholed they have been successfully shot with 40 to 60 per cent. dynamite. In benching Section C in advance of the shovels, vertical holes have been drilled to an average depth of twenty feet or to one foot below grade, and these holes have been spaced twenty feet between centers. Each of them has been loaded with from 125 to 250 pounds of black powder. In those parts of Section C where sandstone has been encountered, a similar procedure has been followed.

As a rule, the heavy cuts have averaged between 30 and 50 feet, but on some of the vertical cliffs the maximum cuts have been as high as 100 feet. Some of our illustrations give a good idea of the character of the canyon through which the road is being carried. As can be readily grasped, the job is not an easy one, and the work could not have been pushed forward with the speed it has without plenty of compressed air to operate the "Jackhamers." Portable compressors have strikingly demonstrated their especial fitness here in hastening roadbuilding in this isolated and rather inaccessible country. Thanks to the portables, the three steam shovels were able to clear away monthly an aggregate of 19,500 cubic yards of muck.

The summer and the winter conditions in Wind River Canyon, showing the hard task confronting the roadbuilders even in the open season.

Progress on the Big Creek Hydro-Electric Project

The Southern California Edison Company, Through This Vast Developmental Work, is Converting the Force of Nature's Falling Waters into Electrical Energy

PART II

By D. H. REDINGER*

THE ORIGINAL scheme for developing energy below Power House No. 2 on Big Creek was to drive a 14x17-foot tunnel, about six miles long, with its intake on Big Creek, and to build a 1,400-foot-head hydro-electric station, to be called Big Creek Power Plant No. 3, on the San Joaquin River about five miles down stream from the mouth of Big Creek. With this object in view, the Pacific Light & Power Corporation started tunnel operations in July, 1914, at the intake end and immediately below the tailrace of Power House No. 2. Work was carried on intermittently with a small crew of men for several years.

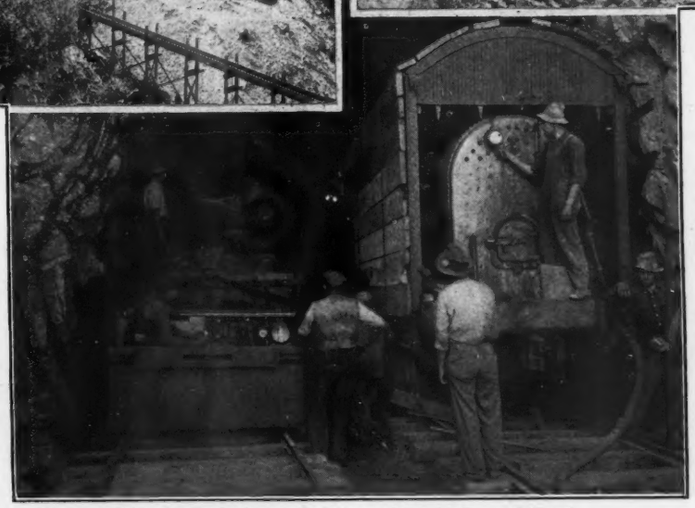
*Resident Engineer, Southern California Edison Co., Big Creek Construction, Big Creek, Cal.

Intake portal of Tunnel No. 8.

On June 1, 1917, the Pacific Light & Power Corporation was absorbed by the Southern California Edison Company, which then continued the work in progress. That the undertaking was carried on slowly is evidenced by the fact that between July, 1914, and February 1, 1920, only 2,050 feet of the 14x17-foot tunnel had been driven—the bench-and-heading method being used. During the latter part of 1919, it was decided to hasten the job then in hand, and, with this object in view, an extension of the existing road from Cascada to Camp 7 at Power House No. 2 was begun along Big Creek and the San Joaquin River in order to reach the various adit points on the proposed tunnel. The first 4,200 feet of roadway, as far as Adit No. 1, was completed January 15, 1920, and a total of 8,400 feet, leading toward but terminating 2,500 feet west of the present Camp 32, was finished by May 1, 1920, when roadbuilding was stopped.

Adit No. 1 was opened up February 20, 1920—the crew living at Camp 7 at Power House No. 2 for the first few weeks. But during the latter part of April a camp, known as Camp 31, was erected at Adit No. 1, and by May 17 a 20x20-foot section, 193 feet long, had been driven. About this time it was decided to enlarge the tunnel cross section to 20x20 feet, and to use the pioneer drift method instead of the bench-and-heading method. This meant the driving of a 9x9-foot heading 3 feet above tunnel grade. Drilling was done with No. 248 "Leyner" pneumatic drills using from 6-foot to 8-foot steels; and air-operated "Shuveloders" were employed for mucking and loading into 1-yard steel dump cars hauled by storage-battery locomotives. Later, rings of holes were drilled perpendicular to the tunnel line, in fan-shaped formation three feet on centers, to the full finished 20x20-foot arched section; and mucking was done with standard steam shovels operated by compressed air. This system was inaugurated at the intake heading on May 5, with 2,355 feet of the 14x17-foot section completed and with 1,415 feet still to be driven to the adit point or to the point of intersection of the center lines of the tunnel and the adit. On May 18, a pioneer drift was started in the adit while 107 feet of the adit remained to be driven to the point of intersection. This point was reached on May 29, and the pioneer drift was then turned east on the tunnel line toward the intake. The drift was "holed through" on August 16, 1920—that is, 103 days of loading at the intake and 79 days of work at the adit heading saw the pioneer section finished.

Driving outlet portal for Tunnel No. 8.



Air-operated steam shovel mucking in Tunnel No. 8.

It is to be noted that all work in progress and contemplated before June 1, 1920, was centered on the installation of the 1,400-foot-head plant and on Power House No. 3. At this time, due to the pressing demand for increased power and to the greater efficiency attained through the perfection of the vertical, reaction-turbine type of water wheel, it was decided to abandon Power House No. 3 tem-

porarily and to develop a 700-foot-head plant, to be called Power House No. 8, on the San Joaquin River at the mouth of Big Creek. This necessitated a complete change of plans; it reduced the total length of the tunnel to 5,933 feet; it did away with the necessity of further extending the road on tunnel grade; and it required a relocation of the forebay, the penstock, and the power house—the new forebay site being 1,820 feet northwest of Adit No. 1. The designating number of the tunnel, the penstock, and all the associate structural work was changed from No. 3 to No. 8.

A characteristic stretch of the line along which excavating was done for Incline No. 8.

A pioneer drift of 1,803 feet between the adit and the location of the new outlet was begun from the point of intersection on June 17, 1920, and from the outlet end on October 16. The intermittent work and the slow progress that attended these activities resulted from the fact that work was being concentrated on the longer section west of the adit toward the intake portal. The shorter length was holed through on February 26, 1921. The outlet heading was driven on tunnel grade instead of three feet above it, as was the case in the other headings, and, in consequence, the following advantages resulted: a smaller number of holes were required for rings for the enlarged section; the bottom broke much better and with less powder; and mucking with the steam shovel was found to be easier on account of the smoother bottom.

As soon as the pioneer heading between the intake and adit No. 1 to the east had been broken through on August 16, 1920, preparations were begun for drilling the rings for the enlarged section. In general, the method was as follows: each fan-shaped ring was drilled from four set-ups on the basis of a pointing diagram which spaced the bottoms of the holes 3 feet on the periphery of the finished section. This called for 22 holes, or about 162 feet of holes per ring. The rings were spaced 3 feet apart along the center line, the upper 16 holes being drilled first by two machines set up on vertical bars 7½ feet above tunnel grade and 3½ feet each side of the center line. By using an 18-inch cross-arm it was possible to drill two rings from each set-up of the vertical bars. The lower 6 holes were similarly driven with two machines set on vertical bars 3½ feet above tunnel grade. An average of one ring per shift, or three rings per day was attained for each location after the drill runners had become accustomed to the drill pointing.

After rings had been drilled for several hundred feet east of the adit, this section was blasted, and a standard No. 40 Marion shovel was started on the mucking. Western 6-yard side-dump cars, operated by 5-ton, storage-battery locomotives, were used for hauling the muck. The large crew of drill runners was then transferred to the intake heading; and the remainder of the section was drilled and blasted from this end entirely independent of the steam-shovel work, as a bank of from 50 to 100 feet of loose rock was always piled up in front of the shovel serving to protect it from blasting.

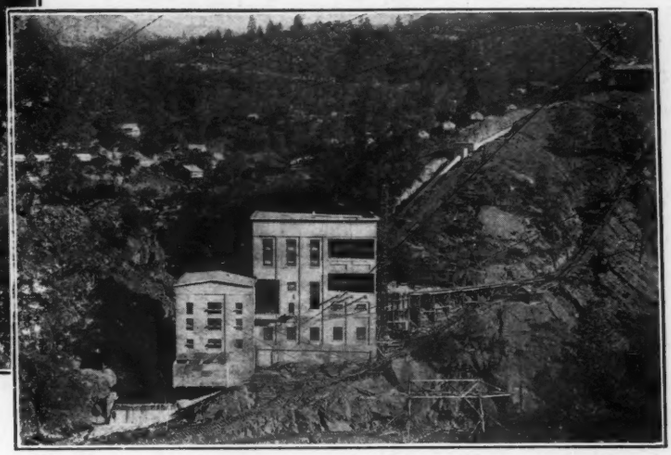
The same system was adopted in enlarging the shorter section between the adit and the outlet portal. Rings were first drilled at the outlet end for several hundred feet; next, a big pile of muck was shot down; and with that done another Marion No. 40 was set to work while the drilling and shooting crew operated from the adit end—progressing in a reverse direction, that is, working from the inside out and keeping 100 feet or more of the tunnel continually piled full of loose rock for the steam shovel.

Progress on the enlargement of the tunnel was of course governed by the speed with which the mucking could be carried on. The steam shovel provided to clear the 107 feet of adit remaining to the point of intersection did all that mucking between September 26 and October 16, 1920, and then turned east into the main tunnel. Mucking was completed as far east as the 14x17-foot section on February 17, 1921, requiring a total of 148 shifts to dig 1,415 linear feet of tunnel, or making an average progress of 9.6 feet per shift. It was considered inadvisable at this time to enlarge the 14x17-foot section driven prior to May 5, 1920, to the full 20x20-foot section, and, therefore, this stretch of 2,415 feet from the intake was left as originally driven. The enlargement of the section between the adit and the outlet portal was begun on April 23 and completed June 10, 1921; and a total of 1,686 linear feet was driven in 133 shifts, or an average advance of 12.8 linear feet was made per shift. The better progress in the latter section was due in part to the fact that the pioneer heading was driven on tunnel

Showing both pioneer and enlarged sections of Tunnel No. 8.

Drilling rings in the pioneer section of Tunnel No. 8.

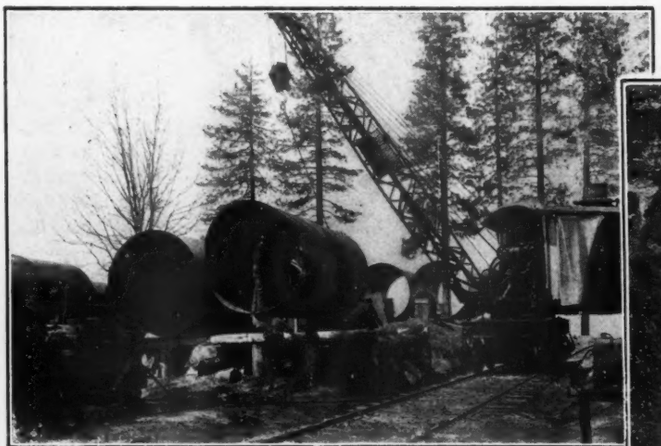
Site of Power House No. 8 at the start of the work.



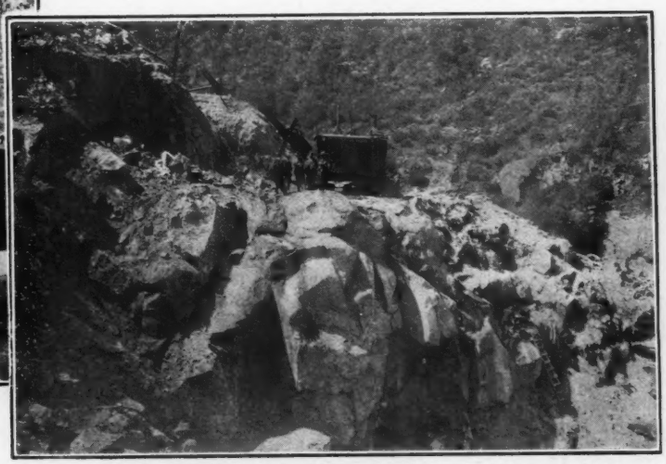
Power House No. 8 when substantially completed.

Camp No. 33 where the men were housed while working on Power House No. 8.

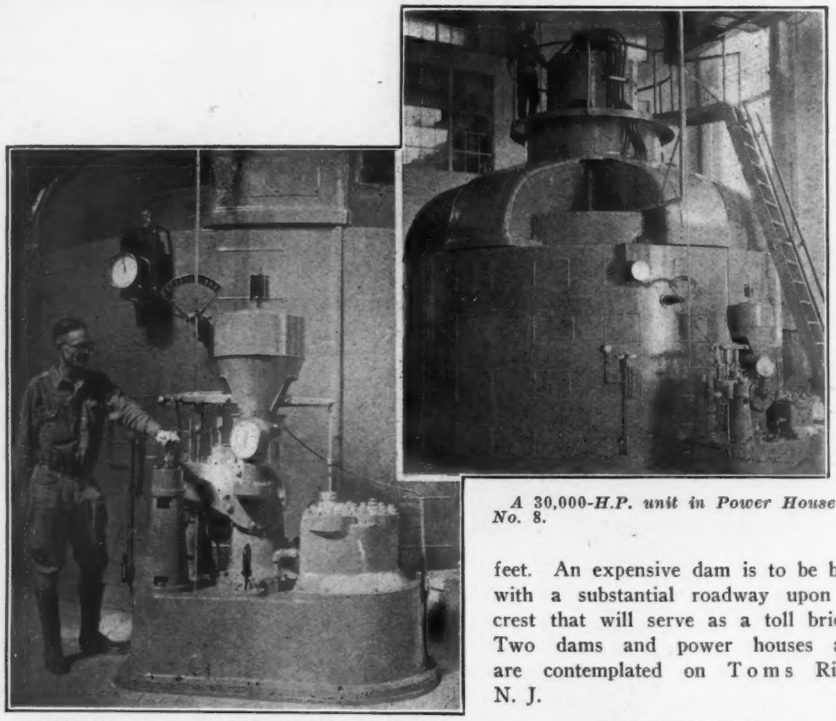
Site of Power House No. 8 with diversion tunnel outlet at left.



Handling riveted sections of the penstock pipe for Power House No. 8.



Much rock had to be removed in excavating for Power House No. 8.



A 30,000-H.P. unit in Power House No. 8.

Hydraulic governor of the 30,000-H.P. unit.

grade from the outlet portal and in part to a more experienced crew and a shorter haul for trains. Owing to the intermittent manner in which the work was carried on, as brought out in the foregoing, it should be evident that it is impossible to give an average figure of advance on Tunnel No. 8 that would fairly represent the rate of progress.

The principal advantage of this pioneer system is that all operations—drilling, blasting, and mucking, can virtually go on at the same time and continuously. Furthermore, a smaller amount of powder per linear foot of tunnel is probably required, in that the enlarged section breaks more easily after the pioneer drift is cut through. It is questionable, however, whether this method, involving a greater number of operations, is more economical than the bench-and-heading method.

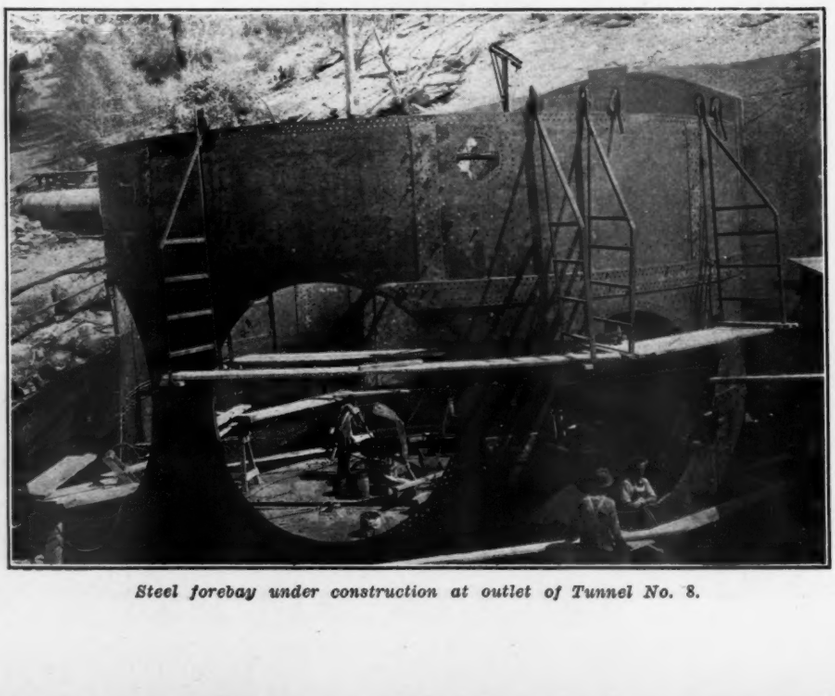
(To be continued)

The Hydro-Electric Company, made up principally of engineers and other professional men living at Harrisburg, has recently been incorporated in the State of Pennsylvania. It proposes to develop two important power sites on the Susquehanna River. One of these is at Clark's Ferry, just above the mouth of the Juniata, and the other at Millersburg, where will be formed a pool which will develop a head of 50 feet. An expensive dam is to be built with a substantial roadway upon its crest that will serve as a toll bridge. Two dams and power houses also are contemplated on Toms River, N. J.

STAINLESS STEEL MAKING PROGRESS

IMPORTANT work in connection with corrosion problems is being carried forward by the Bureau of Standards, and Dr. G. K. Burgess, Director of the Bureau, says that great strides in the employment of non-corrosive steels are to be expected in the near future. The cost of certain forms of the steel has already been cut two-thirds by the improvement of processes.

This is a matter of great importance. The waste represented by the corrosion of steel is so great that its prevention by the development of these special steels must be regarded as one of the most outstanding and promising of present-day trends in the steel industry.



Steel forebay under construction at outlet of Tunnel No. 8.

AN ENGINE STETHOSCOPE

OLD engineers have trained ears and are quick to detect, by sound, slight aberrations which develop in constantly running machinery. The condition of main bearings, for instance, or any abnormality of condition, can often be deduced from the slight murmurs which accompany their functioning. In a busy engine-room, however, it is difficult to detect the minute, individual sounds amid the general din.

With a view to enabling abnormal noises in a bearing to be readily detected, so we learn from an English authority which fails to give the most desired particulars, an electrically operated stethoscope has been devised by means of which the noise given out by the bearing is transmitted to some distant point, such as the chief engineer's office.

The stethoscope consists essentially of a microphone which is screwed into the bearing cap—one electrode of the microphone being in right metallic contact with the bearing, participating in all its movements, while the other electrode, completely insulated from the first, is placed in the circuit of a dry battery or other source of current. The relative movement of the two electrodes sets up a sound which is accurately reproduced at the receiver, just as are the sound waves from a microphone or a telephone.

HIGH VALUE OF SLAG

THE present status of blast-furnace slag is a striking example of the working of modern methods in the transformation of industrial waste products into materials of high value and great demand. British blast-furnace owners are now reaping profits from the big slag heaps which have been accumulating as waste for many years. At a meeting of foundrymen, at Manchester, it was said that pig iron can now almost be described as the by-product—there being little or no profit in it—while the slag is the valuable material that is in demand.

About ten years ago, roadbuilders began buying slag as a substitute for granite. The slag is first crushed and then mixed with tar. The Stanton Ironworks, Manchester, is selling 40,000 tons of slag per month; and 20,000 tons of it is treated with tar. Four years ago there were slag heaps at the Stanton plant made up of 5,000,000 tons of this erstwhile waste product, and these have been so reduced in the meantime until today only 250,000 tons is left.

Petroleum Resources of the Dominion of Canada

By M. CHOSE

IN REVIEWING briefly the petroleum situation in Canada, let us begin with the statement that the Dominion can claim the possession of oil fields scattered from ocean to ocean and from the International Boundary to the Arctic Circle. Lest such a far-reaching assertion lead to undue complacency regarding our natural resources, we must hasten to admit that, apart from a small corner of Ontario, these Canadian oil fields are not at present commercial producers—whatever they may have been in the past or may aspire to be in the future. Let us review these fields in order from east to west.

Like our cousins south of the line, the first use to which we put petroleum was a medicinal one. More than a century ago, in 1812, a Mr. Parsons, in Newfoundland, is reported to have resorted to crude oil as a cure for rheumatism; and in 1867 the first well was sunk at the spot from which he drew his supply in an attempt to develop production. Periodic ventures have been made since then towards this end without great success; but a determined effort is now under way to prove the oil possibilities of the island—the government having granted a monopoly to an influential company for a period of years.

In Nova Scotia, a number of wells have been drilled within the past 50 years on the shores of Lake Ainslie, Cape Breton Island, but the results have not indicated the presence of commercial quantities of oil. In New Brunswick, on the other hand, the prospects are rather favorable: there being a suitable geological structure for the accumulation of oil. Much drilling has been done there; but the production for 1921 amounted to only 7,479 barrels. The future development of oil in this province would appear to be along the line of distillation of the very rich shales which are present in abundance; and large British interests have already investigated this source of supply. The time, however, is not yet ripe for the profitable exploiting of such a scheme.

The principal area of interest in Quebec is the Gaspé Peninsula. The first drilling was done in this field in 1868; and a large number of holes have since been put down. Small quantities of oil were obtained, but the outlook can hardly be considered favorable for the production of oil on a commercial scale. In certain other counties of Quebec unsuccessful attempts have been made to find oil, and from all indications that territory would not seem to promise much in the way of oil-bearing sands.

The development of the Ontario fields followed closely upon the discovery of oil in Pennsylvania. In fact, it is an open question whether the honors bestowed on Drake should not have been awarded to Williams who drilled a deep well at Oil Springs, in 1857, with satisfactory results before the famous Titusville gusher was brought in. By 1860, hundreds of derricks had been erected at Black Creek—the depth of the wells seldom exceeding 100 feet and the annual production being around 150,000 barrels. In 1862 a gushing well came in with a yield of nearly 2,000 barrels per day. A large amount of this oil went to waste: in fact, it is estimated that in the spring and the summer of 1862 something like 5,000,000 barrels were carried away by the waters of Black Creek.

In 1867 the center of interest had shifted from Oil Springs to Petrolia, but the wells of the former field were subsequently drilled deeper with encouraging results. These two areas have proved to be vastly productive. Other fields were opened up at Bothwell, Dutton, Tilsonburgh, and in many other localities in southwestern Ontario—some of the later pools, such as Moza, coming in with a large flush output which, however, rapidly declined. Efforts have been and are being made to extend the productive area, but it is doubtful if other pools of any considerable size will be uncovered.

Production in Ontario has long since passed its peak, as the following figures will show, but the longevity of the field is something to marvel at inasmuch as many of the more notorious and richer fields in the United States have risen and declined while Ontario may be likened to Tennyson's brook—going on forever.

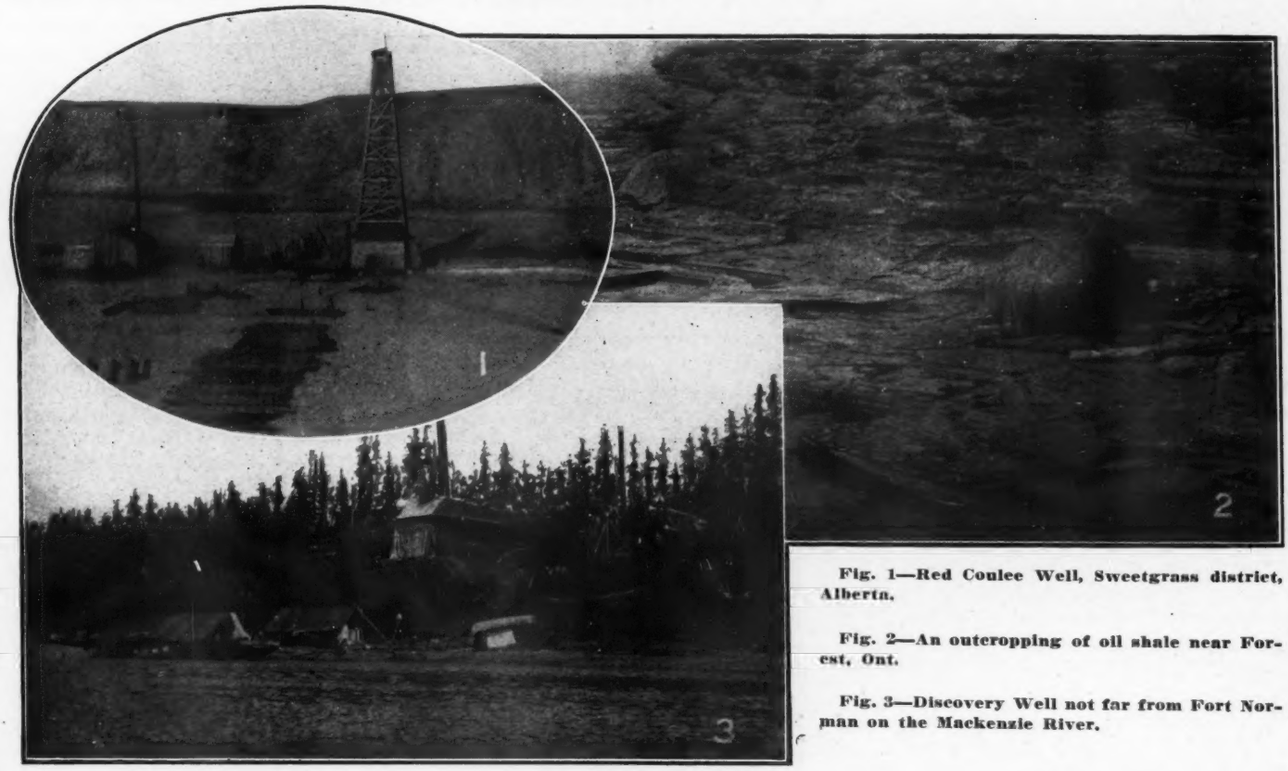


Fig. 1—Red Coulee Well, Sweetgrass district, Alberta.

Fig. 2—An outcropping of oil shale near Forest, Ont.

Fig. 3—Discovery Well not far from Fort Norman on the Mackenzie River.

	Quantity
1870	230,000 barrels
1880	350,000 "
1890	795,030 "
1900	913,498 "
1910	315,895 "
1921	172,858 "

No oil wells of importance have been drilled in Manitoba, and it is questionable if worthwhile returns will reward the efforts now being made. An area in the northern part of the province has recently received attention; and it is hoped that something may be done with the oil shales in that region. Drilling is also being resorted to in the territory; and there has been considerable staking. From all appearances, however, the chances of a big strike are remote.

In spite of rather extensive drilling there has been no cause for excitement over the results in Saskatchewan. Drilling has been done close to the International Boundary in the Cypress Hills, at a spot farther north near "Muddy Lake," and at Rush Lake close to the South Saskatchewan River. All these wells have been abandoned—having been proved "dusters." There are still some prospects for oil in Saskatchewan, as there are certain evidences of a favorable structure; and bituminous horizons are thought to underlie the surface formations at a convenient depth for drilling.

The problem of eastern Alberta is largely like that of western Saskatchewan—similar conditions prevailing as regards formations and structure. Here again drilling has been carried on in an effort to try out the territory, and dry holes have been made at Tit Hills and Misty Hills. These wells proved an alarming attenuation of the lower members of the Cretaceous, only a few hundred feet being encountered between the base of the Benton and the Devonian limestones. So far the only profitable drilling has been the uncovering of a fairly large gas field in the vicinity of Fabyan, and this may yet prove an asset. As numerous locations have been made by various interests, this territory will not be condemned without a thorough examination. The bringing in of the Kevin-Sunburst field in Montana has given an impetus to further search in the Sweetgrass area of southern Alberta. Much drilling has been and is being done, but so far no commercially successful well has been brought in.

Courtesy Canada Department of Mines.

Good exposure of tar-sand formation lying on the Athabasca River.

Coming to the western area of Alberta, conditions are quite unlike those obtaining in other parts of the province. Here we have the effects of mountain building demonstrated on the Cretaceous sediments in a succession of long, narrow folds running parallel to the Rockies. Numerous favorable structures have been noted and tested. Western Alberta has been slow to recover from the effects of the oil boom of 1914, which was marked by rash speculating and wild-catting. Now, however, a comprehensive effort is being made to prove or to disprove the value of the territory, and many companies and individuals are working to that end. One enterprise has drilled seven or eight wells along the outer fold, where conditions are most favorable, but so far the only achievement has been to bring in a substantial "gasser" at Pouce Coupe, near the Peace River. The "Dingman" field southwest of Calgary, which has been western Canada's only producing field for some years, is also being developed, and a plant for the absorption of gasoline from natural gas is in operation there. This gas, after treatment, is turned into the mains for use in Calgary.

A great deal of drilling has been done in the Peace River district without notable result. Many of the wells were abandoned owing to water troubles; and production has been moderate. The Cretaceous sediments there are nearly flat, and it appears that drilling may have to be carried to the Devonian before success is met with. As the Cretaceous lies unconformably on the Devonian, the locating of a well on surface evidence is more or less guesswork. The total production in Alberta in 1921 was around 11,000 barrels, but hope is expressed that this may be materially increased before long.

We cannot leave Alberta without referring to the famous "tar sands" of the Athabasca River. Commencing at the Crooked Rapids, there are cliffs of this peculiar formation that rise to heights of 230 feet and extend for a distance of 100 miles down stream. Tar sand is a sandstone formation saturated with a dark viscous oil. It is soft and plastic, and oil can be squeezed out by hand. If a hole is dug in the outcrop, oil will accumulate. It is possible that an oil industry will eventully grow out of these tar sands; but, previous drilling having proved futile, such an outcome will depend on the ingenuity of the driller in devising methods to circumvent the viscosity of the oil, or on the skill of the chemist in finding means to extract by retorting.

Oil development in British Columbia is still in the speculative stage, and the government of that province is conducting surveys and putting down diamond-drill test holes for the in-

Courtesy Canada Department of Mines.

An outcropping of low-grade and bituminous sand overlying Devonian limestone.

formation and guidance of interested parties. In the past, the islands in the vicinity of Vancouver have received attention, as has also the Fraser Valley, but the results have not been encouraging. Small production was at one time obtained from wells in the southeastern part of the province near the Albertan boundary. One well was reported good for twenty barrels a day. Seepages are numerous in the gravels of Oil Creek and in the argillites of Seepage Creek; but there is not much chance of any substantial development.

The oil indications in the northwest territories are widespread. In the area drained by the Mackenzie River there is a geosyncline or great basin of Devonian rocks on which remnants of the Cretaceous and Tertiary have been preserved. Seepages from these rocks arrested the attention of the earliest explorers, and interest gradually intensified until, in 1914, a purely oil survey was carried out. The findings were so satisfactory that two areas were tested by drilling during 1919—the most southerly at Windy Point, Great Slave Lake, and the other below Fort Norman on the Mackenzie River.

At Great Slave Lake the results were disappointing, as the hole entered "granite" at 1,800 feet without revealing more than a show of oil. Little hope is entertained for this area as the oil-producing rocks are either at or near the surface, but there may be sections nearby where these horizons can be tapped away from their outcrop with better result. The well near Fort Norman gave greater promise, coming in as a "gusher" at a depth of 783 feet. This production has now dropped to around 75 barrels per day, and further drilling has not demonstrated the presence of oil in large quantities.

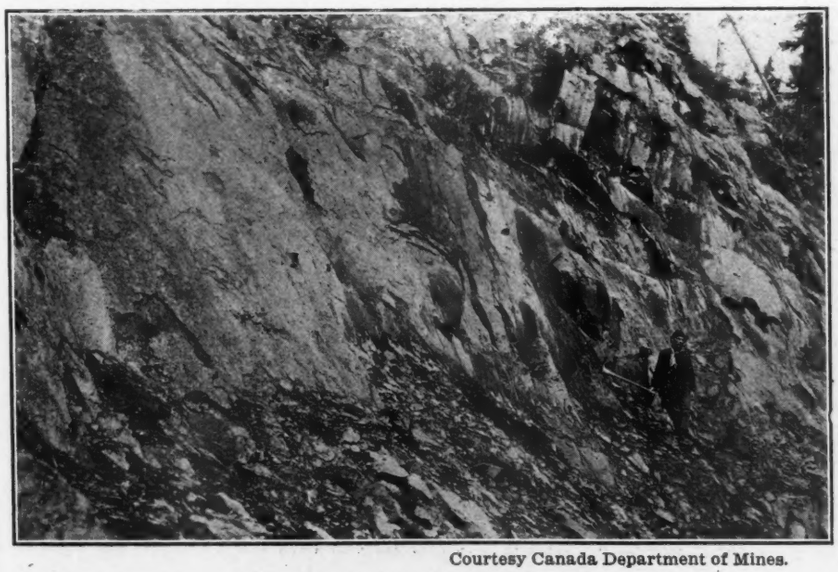
The Fort Norman area has all the superficial appearance of an oil field. There are bituminous formations of considerable thickness and extent, and above them are rocks of such lithological character as to make them admirable reservoirs. Surface indications of oil and gas are abundant, and anticlinal structures are numerous. The one fly in the ointment is the fact that the crests of the structures so far met with are all eroded down to or below the oil-bearing formations; and therefore drilling on the structurally favorable spots entails commencing a well where it should logically end. Under present conditions it can only be hoped that the investigations now being carried out will prove a profitable investment for future generations.

Thus we see that oil development in Canada is largely in its initial stages. Let the future hold what it may, there is no denying the pressing need for a domestic supply of petroleum; and due credit should be given to those companies and individuals that are bending their energies toward this end.

Courtesy Canada Department of Mines.

Local crumple in the Albert series where oil shale is exposed along the main branch of Frederick Brook.

Australia is the leading export market for American automobiles. The value of the cars exported direct to Australia in 1922 was $23,000,000. In addition, considerable exports were made by Canadian branches of American manufacturers. Now let us remember that the total population of Australia is less by 400,000 than that of New York City, not including any of its suburbs.



Courtesy Canada Department of Mines.

Massive structure of high-grade deposit of bituminous sand on Steepbank River.

LIGHTHOUSE PROGRESS

TO EGYPT belongs the credit for having erected the first lighthouse on record and, now, also for building one of the latest, as described in a recent issue of *Engineering*, London. Comparisons of the old with the new, and especially as to the means of illumination, are inevitable.

The first lighthouse was built on the Island of Pharos, at the mouth of Alexandria harbor, about 600 years before the Christian Era. It was 100 feet high and stood until the fourteenth century, when it was washed away by the sea. Its light was an open fire of burning wood; and this practice was followed until the beginning of the seventeenth century. As late as 1790, the South Foreland light was merely a beacon fire of coal.

The famous Eddystone Lighthouse, in 1759, was illuminated by ten pounds of tallow candles—a clock being provided to ring a bell every half hour to remind the keeper to snuff them. In 1763, oil lamps with reflectors were used for lighting the Mersey Channel; and after the invention of the Argand burner, twenty years later, oil became the standard illuminant.

Mineral oil was introduced in 1872, and, in due course, the concentric wicks of the Argand burner gave way to the incandescent mantel, which now furnishes light for all the most important lighthouses in the world.

In order to relieve unemployment, the British Government is soon to start on a road-building plan which calls for an expenditure of substantially $11,000,000. In this connection, P. M. Stewart, head of a delegation representing 90 per cent. of the cement manufacturers in England, announced at a recent meeting of the Portland Cement Association that America is far ahead of Great Britain in the matter of roadbuilding. Therefore, in carrying out its programme, American ideas in concrete highway construction are to be largely adopted.

Zinc Mining in the United States

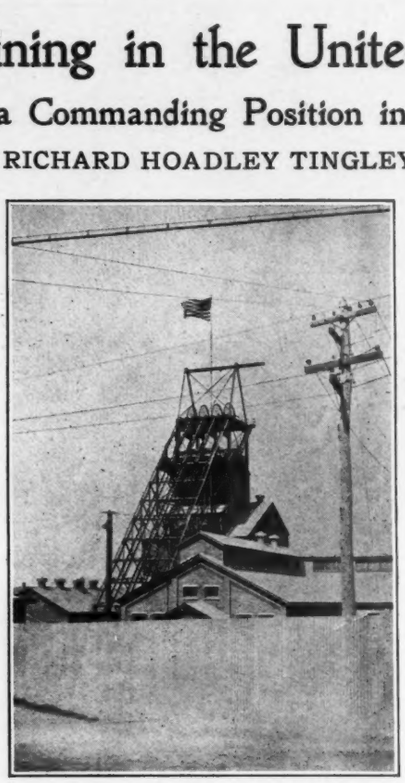
America Has Assumed a Commanding Position in this Important Industry

By RICHARD HOADLEY TINGLEY

THERE is abundant evidence that zinc was known to the ancients even though its production was limited and its use but infrequent. However, the nature of the metal was but little understood. For this reason zinc has been called "The Mysterious Metal." It is only within the last hundred years that metallurgists have discovered methods of reduction that have made it possible to produce at reasonable prices zinc sufficiently pure and malleable to be made into sheets. But the last generation has seen rapid progress in the art; and so much has been learned of the mineral, its usefulness, and the means employed to retort or smelt it that a prominent zinc man, with a poetic turn of mind, remarked that, like the oriental woman, the mysterious metal was "fast ridding itself of the veil."

It is estimated that in 1860 the total production of slab zinc in the United States was but 800 tons. By 1914 it had been increased to 400,000 tons—rising to 720,000 tons in 1916 only to drop back to 485,000 tons both in 1919 and in 1920. In 1921, the general depression drove the output down to 215,000 tons, while the year 1922 saw a "come back" to 374,000 tons.

The United States is by far the largest producer of slab zinc, furnishing approximately 60 per cent. of the world's supply. Germany is the nearest competitor, with Belgium, France, and Japan following in the order mentioned. In this country, the principal zinc mining districts are in northern New Jersey, eastern Tennessee, Illinois, Wisconsin, Missouri, Kansas, Oklahoma, Montana, Idaho, and other western states; and it is estimated by the Geological Survey that we possess 36 per cent. of the zinc resources of this globe of ours. Mr. William A. Ogg, one of the best-informed zinc men in this country, claims that the deposits of zinc in the United States can, as a rule, be more easily, cheaply, and quickly opened up, developed, and operated than deposits of other metals, such as copper, silver, gold, and the like. This is particularly true of the Joplin district, where the ore bodies are but from 150 to 300 feet below the surface.

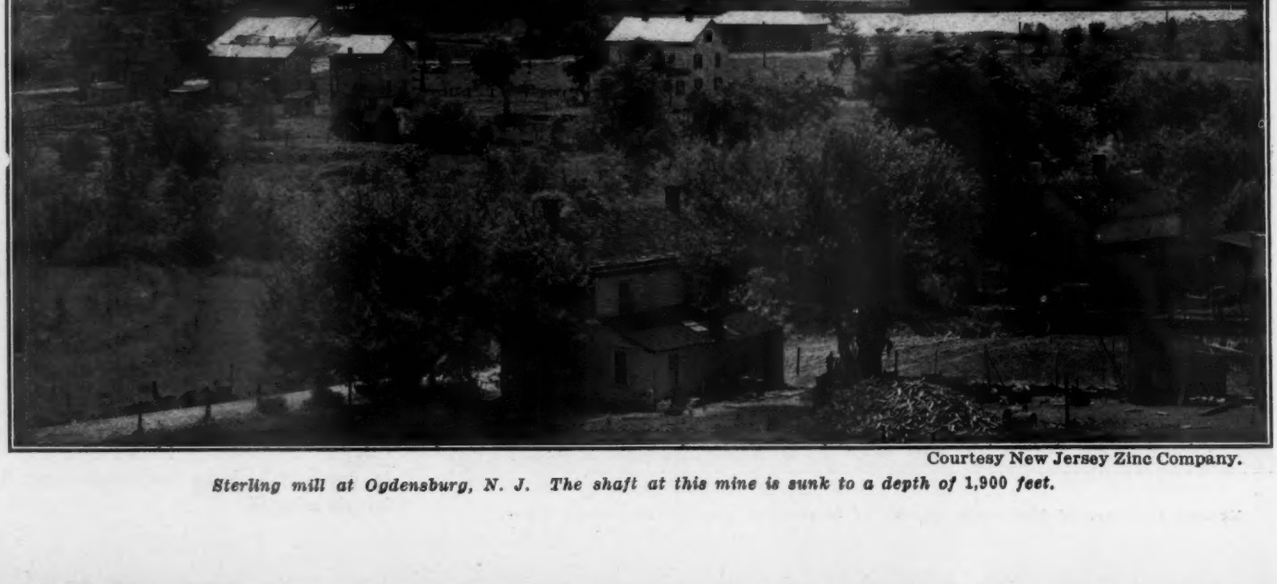


Courtesy New Jersey Zinc Company.

Palmer shaft headframe, Franklin, N. J. The shaft is 1,150 feet deep and is inclined about 47 degrees from the horizontal.

After the ore has been mined, concentrated, roasted, and distilled or electrically treated it becomes the slab zinc of commerce, and, in this form, is extensively used in the arts; in the manufacture of brass; for zincing or galvanizing iron and steel; for roofing, etc. Except in the case of electrolytic plants, the ore is distilled in furnaces, fired by natural or producer gas, and is roasted at the smelter to remove the sulphur content. This, in turn, is converted on the premises into sulphuric acid.

Prior to 1914, approximately half of the slab zinc produced was used in zincing or galvanizing plates and wire, but war requirements brought about a change. At that time, around 40 per cent. of the slab zinc manufactured



Courtesy New Jersey Zinc Company.

Sterling mill at Ogdensburg, N. J. The shaft at this mine is sunk to a depth of 1,900 feet.

was used with copper for making brass—substantially a third of which was composed of zinc; and because of the demand for brass for ammunition and gun parts the greatest outlet for the metal was in that direction. The remaining 10 per cent. of the pre-war output was rolled into plates and sheets to be used in the production of shingles and corrugated sheets, a considerable quantity of which was exported. The War Industries Board, in its efforts to conserve other less plentiful metals, published a list of over 150 different ways in which zinc in its various forms could be used. High explosives sent abroad during the conflict were shipped in zinc-lined containers because that metal resists atmospheric influences. Without the "zinc sender"—an automatic telegraphic device—high-speed signaling through cables could not be accomplished.

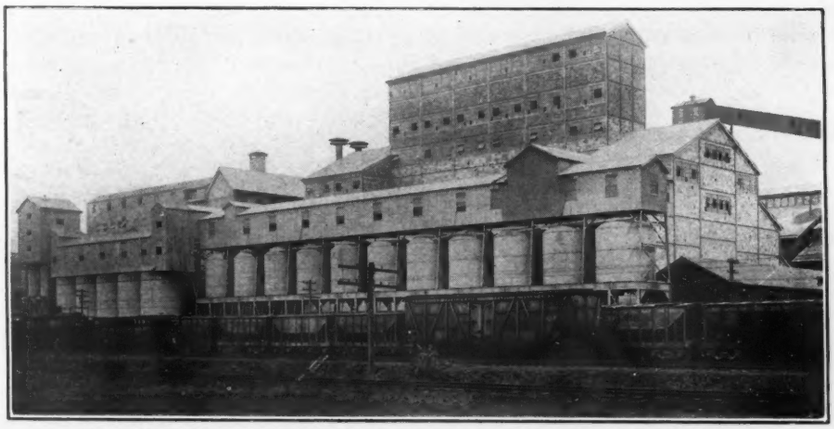
The war demand upon the zinc industry resulted in speeding up the production to previously unheard-of quantities. New mines were opened, smelters were enlarged, and plants were built. At the close of hostilities, the industry was equipped to do practically double the business done in normal times. Previously, there had been a lack of coördination among zinc miners and smelters. The situation strongly suggested that teamwork might be more advantageous than individual, independent effort, and finally led to the organization, in 1918, of the American Zinc Institute for the purpose of "putting zinc on the map." This was to be done by educating the public; by promoting coöperation in mining and in smelting the ore and in marketing the product; and by encouraging the discovery of new fields of employment for the mineral in order to make it possible to utilize at least a part of the war-developed capacities.

Rolled zinc takes a high polish or a dull or frosted finish, and may be formed into complicated shapes. It can be enameled or plated with gold, silver, nickel, or brass without annealing, and can be given any of the finishes common to brass and bronze articles. Sheet zinc, for sheathing houses, factory and farm buildings, etc., prevents molding and keeps out water, cold, and vermin. This is said to be one of the coming applications of the metal. The enduring nature of zinc is an acknowledged fact.

No business is up to date nowadays without a slogan, and that of the zinc industry is "Make it of Zinc." It was realized, however, that it would not be of any great advantage to tell the public merely to make things of zinc, but that it must be told what to make and how to make it. By following up this line of reasoning with wide publicity, the American Zinc Institute has been instrumental in creating new markets for zinc products, and this is helping materially towards making it practicable to operate existing plants to capacity.

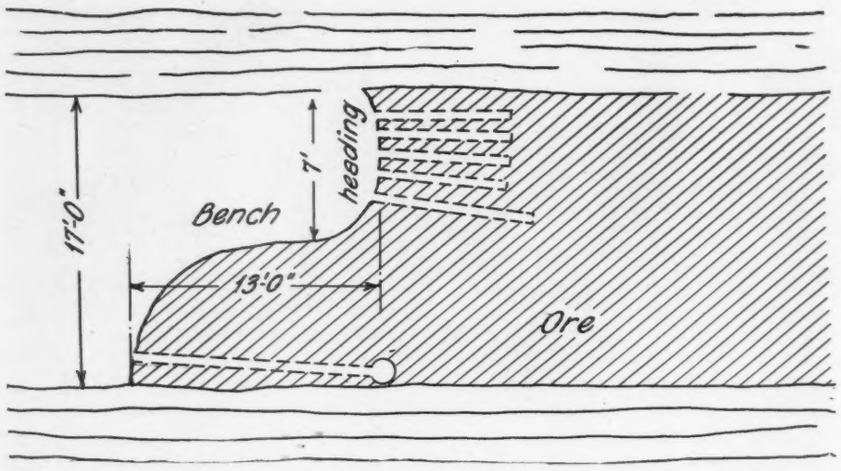
In the mining of zinc, as in the mining of all metals and minerals, it is necessary to call upon compressed air to perform many kinds of work. In the Joplin district, the ore deposits, which are relatively horizontal and lie at shallow depths, are reached by vertical shafts sunk at frequent intervals. The depths of these shafts are generally from 100 to 300 feet,

The oil furnace and "Leyner" sharpeners are indispensable to a blacksmith shop called upon daily to keep numerous drill steels in proper condition for efficient work.



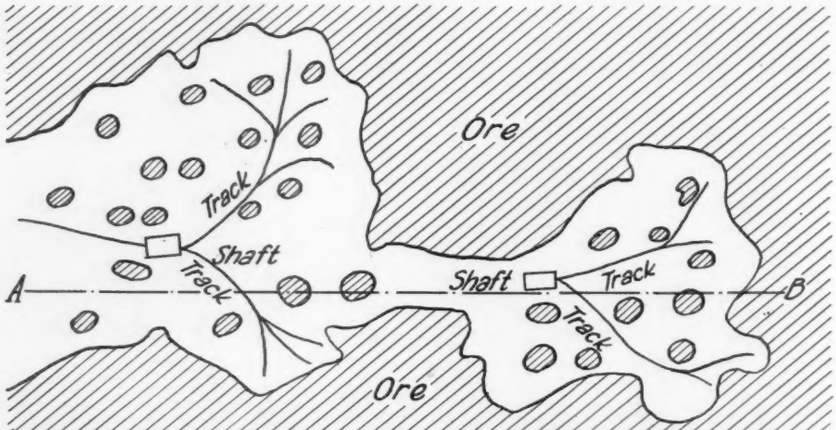
Retreatment house of the New Jersey Zinc Company at Franklin, N. J.

Driving a crosscut with a Leyner-Ingersoll No. 248 drill.

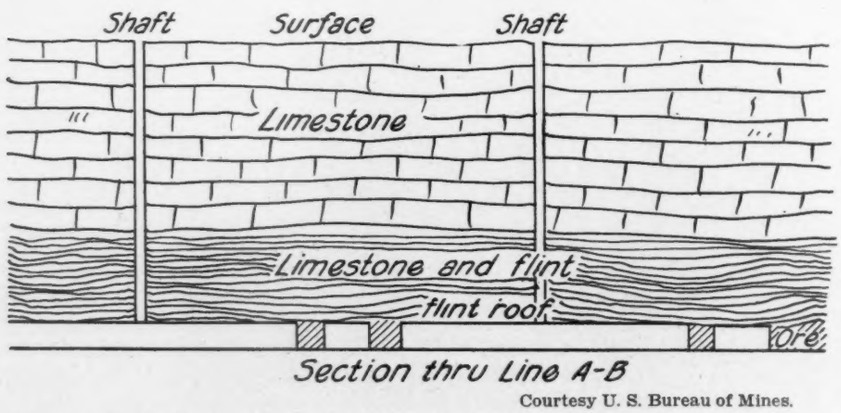


but they are sometimes less than 100 feet and may reach down nearly 400 feet, as is the case in several of the mines in the Miami district of Oklahoma. Ordinarily, the ore bodies are worked on one level, as the deposits are seldom more than 30 feet in thickness. Where there are two distinct runs of ore above one another, and separated by a relatively thick stratum of barren rock, the two runs are usually mined independently and at different times.

Where possible, a system of underhand stoping is practiced, particularly in the sheet-ground mines, provided there is a working face high enough to warrant stoping. Accompanying diagrams show this method. Pillars are left at frequent intervals. In sheet-ground mining, machine drills are usually set on a 7-foot column placed at the upper part of the working face near the roof in order to advance the heading about 6 or 8 feet. When the heading has advanced anywhere from 15 to 25 feet, the underlying bench is drilled and blasted. This bench is generally 9 to 12 feet thick, giving a total working face of from 15 to 20 feet.



At some of the Tri-state mines it has been found practicable to raise a shaft. A cable, attached to a small headframe at the surface and passed through a drill hole to the underground workings, supports a platform. This platform is raised and lowered by means of the cable and is used to carry the air drills and the drill runners. After a round of holes has been drilled in this unique way, the holes are charged and blasted—the platform being removed before the charge is set off. By this method, the face is always clear of broken rock; and it has been found that the cost of raising a shaft in sheet ground is less than that of sinking to the same depth.



Courtesy U. S. Bureau of Mines.

Diagrams illustrating manner in which a system of underhand stoping is employed especially in sheet-ground mines.

The cost of shaft sinking in the Joplin district varies according to the nature of the ground, the amount of water encountered, and the size and the depth of the shaft, and averages anywhere from $10 to $20 per foot for a 200-foot shaft. In 1918, the actual cost of sinking a 6x10-foot shaft in the clear to a depth of 210 feet was $3,260.92, or $15.53 per foot.

The uses of air in deep zinc mining may best be illustrated by describing the equipment and the operation of the Hecla Mining Company near Wallace, Idaho; and the following facts and figures are supplied through the courtesy of Mr. James F. McCarthy, the manager. There the ore bodies are from 3 to 40 feet wide, and nearly vertical, though they sometimes dip slightly. The shaft is divided into three compartments—two for hoisting the ore and one for auxiliary work—and its outside dimensions are 19 feet 4 inches by 7 feet 2 inches. The working compartments are 5 feet 2 inches by 4 feet 4 inches, inside measurement. The rest of the shaft contains the pump column, electric cables, air piping, and the ladderway.

Solid formation is reached at a depth of 80 feet—the bottom of the shaft being 2,212 feet below the surface. The main haulage drifts are 8 feet wide by 8 feet high—increasing to 15 feet in width when ore is encountered. Compressed air is carried down the shaft through a 6-inch pipe to receivers placed at the working levels. In the main drifts, 4-inch air piping is utilized; in the raises, manways, and stopes it is 1¼ inches; and in the crosscuts it is 6 inches in diameter. Air at a pressure of from 90 to 100 pounds is supplied.

For drifting, crosscutting, and stoping, "Leyner" drills No. 248, weighing 156 pounds, are employed with 1¼-inch round, hollow drill steel. For raises, and for some stoping, the Ingersoll-Rand CCW-11 wet stoper of 93 pounds is used. BCRW-430 "Jackhamers" drill boulders preparatory to blasting in stopes, while mounted "Jackhamers" do the crosscutting in isolated places. With the latter, two men can drive a 5x7-foot crosscut and make an average advance of 4 feet per round or shift. Unmounted, this tool weighs 47 pounds. All steels are made up and sharpened on "Leyner" sharpeners.

Compressed air is used at the Hecla mine for the following purposes:

In the mine—
- Machine drills;
- Hoists;
- Sinker pump;
- Air lifts on skip-pocket gates;
- Air motors for ventilating fans;
- "Little Tugger" hoists;
- Air lift to dump waste cars.

At work on a heading with a BCRW-430 "Jackhamer."

On the surface—
Steel sharpeners;
Trip hammer in the blacksmith shop;
Hoists;
Riveting machines in shops;
Brakes on electric hoist;
Air lifts on ore bins;
Cement gun;
Waste dump: power to raise or lower apron to divert material hoisted to ore or waste bin;
Boring machines in carpenter shop;
Blow guns in blacksmith and machine shops;
Blast in brass furnace;
Inflating tires in garage;
General cleaning.

The Hecla mine has had much trouble with water. To overcome this, an old sinker-pump air end and body piece were converted into a pump for forcing cement under heavy pressure into rock fissures to stop the flow of water. The leakage was copious and persistent; but the improvised cement gun—which is illustrative of the unusual services to which resourceful mine foremen and engineers put compressed air and other machinery—has operated so successfully that little water trouble is now experienced.

The Tri-state district is the best known and the largest zinc-producing area in the world. Indeed, the name of its principal city, Joplin, has become almost synonymous with zinc operations; and the territory supplies approximately 61 per cent. of the country's production of that metal. Montana and the Wisconsin - Illinois districts come next. The biggest and oldest single zinc-mining camp in the world, however, is in northern New Jersey at the Franklin and Ogdensburg workings of the New Jersey Zinc Company. Since 1880, this company has produced more than 10,000,000 short tons of zinc ore—its record for a single year, that of 1919, being 639,714 tons. The pitch of the New Jersey ore bodies is about 47 degrees from the horizontal, and the shafts are sunk at approximately that angle. The ore is mined at various levels to a depth of nearly 2,000 feet.

The zinc industry, with its hundreds of mines and its 80,000-odd operating retorts has recovered, in large measure, from the depression of 1921 and 1922, in which latter year about half the given number of retorts were working. This is due, in part, to the activities of the American Zinc Institute, as previously mentioned. The average pre-war price of zinc was about 5 to 6 cents per pound. In 1915 and 1916 it advanced to from 13 to 14 cents—dropping back to the low figure of 4.19 cents in August, 1921. Thereafter, the rise was steady, reaching as high as 7.87 cents in March of 1923; and then the price declined and remained firm in July, 1923, when it reached around 6.25 cents, St. Louis delivery.

Until recently stocks of zinc continued to diminish, indicating that consumption was catching up with production. At the end of March, 1922, zinc stocks amounted to 60,262 short tons. At the end of April, 1923, they were reduced to 8,976 tons. With the slowing down of business in the spring months, however, stocks again began to accumulate, reaching 17,173 tons on June 30, 1923, which fact was responsible for the aforementioned drop in price.

Everybody knows that iron is an important constituent of the human body, but it remained for Professor Delezenne of the Pasteur Institute, Paris, to discover by accident that zinc, likewise, is necessary if one would be well nourished. "He's looking well and hearty" you say to a friend. The new reply, as suggested by the *Joplin News-Herald*, is, "Yes, he is, he must be full of zinc."

To the Secretary of the American Zinc Institute, Mr. Stephen S. Tuthill, the writer is indebted for much of the data and information contained in this article.

Drilling a raise with a CCW-11 stopehamer.

Miners about to descend 1,000 feet into the bowels of the earth at the Palmer shaft of the New Jersey Zinc Company.

BIG EXHIBITION COLLIERY

AT THE British Empire Exhibition, to be held near London next May, there will be a model colliery of unusual proportions and completeness showing the workings both above and below ground. The headframe and tipple will be of steel, 70 feet high, with all the accompanying equipment, scales, car hoist, rotary dumps, screens, washery, fan, lamp room, etc. The shaft will be 15 feet in diameter, and will be provided with arrangements for lowering 1,000 people per hour—carrying 20 in a cage. There will be ¼ mile of underground workings, showing longwall and pillar-and-stall methods with all the general mine equipment, pumps, haulage, coal cutters, stables, etc. It is said that the total cost of the model will run up to $500,000.

PAINTING CENTER LINES ON MICHIGAN HIGHWAYS

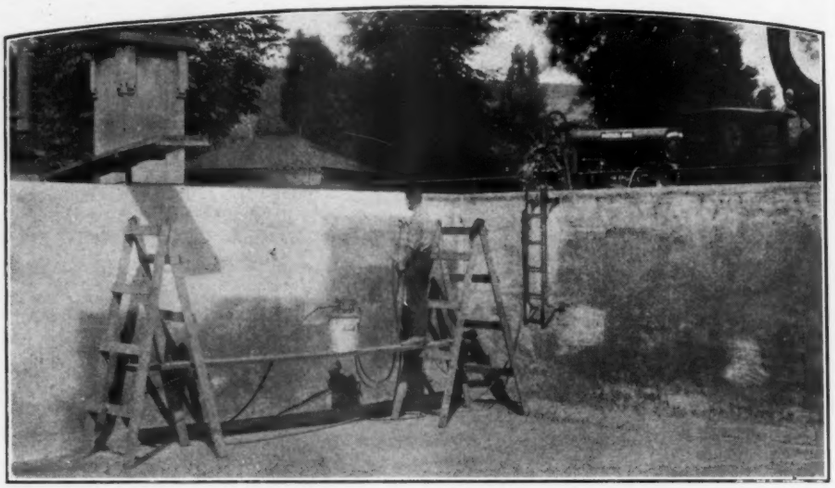
TO REDUCE the cost of painting a white stripe down the center of its concrete highways, the road commissioners of Wayne County, Mich., have devised a portable, pneumatic outfit which accomplishes this work at a substantial saving in time and labor. The equipment consists of a compressed air paint-spraying machine which is mounted on skids and firmly bolted to the floor of a truck.

A wooden wheel, about two feet in diameter, four inches wide, and covered with a strip of felt approximately one inch thick, revolves on an axle which is part of an iron frame attached to the rear of the truck. This wheel is so placed that it follows in the track of the left-hand wheels of the truck. As the truck is driven down the road, paint is sprayed directly onto the felt about one foot above the roadway; and as the felt-covered wheel trails after the truck the paint is immediately transferred to the pavement. When not in use the iron frame and the wheel are raised and placed on the truck.

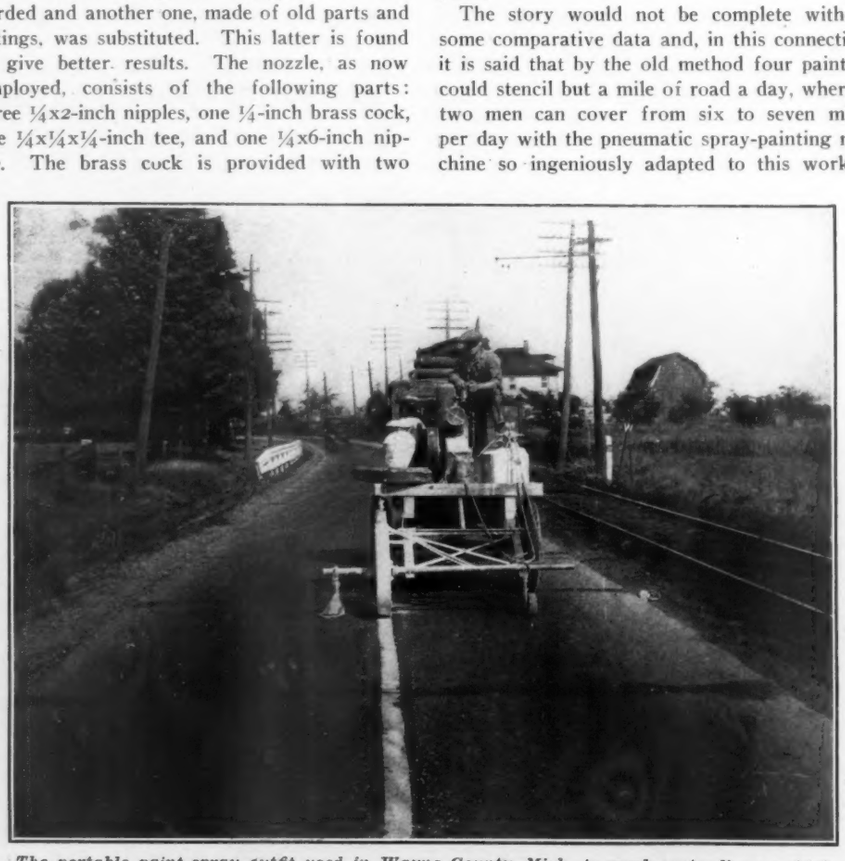
White paint is used because many of the old concrete roads are difficult to follow at night. Before the paint is applied, the middle of the highway is marked with chalk about every 50 feet to guide the driver in centering the stripe, or, if the road is already so divided for the convenience of automobilists, the driver simply proceeds with his left-hand wheels over the old line.

For this work, the spray gun, with which the truck was originally equipped, was discarded and another one, made of old parts and fittings, was substituted. This latter is found to give better results. The nozzle, as now employed, consists of the following parts: three ¼x2-inch nipples, one ¼-inch brass cock, one ¼x¼x¼-inch tee, and one ¼x6-inch nipple. The brass cock is provided with two 2-inch nipples, one in each end. One of these is attached to the paint hose and the other is secured to the tee. By means of this nipple the tee is connected to the air hose, while the ¼x6-inch nipple, which is the business end of the nozzle, is attached to the other end. The air is turned on at the regulator and allowed to flow steadily, thus preventing the nozzle from clogging. The paint is then fed, as desired, by turning the handle of the brass cock. The nozzle is clamped to the rear end of the body of the truck and is protected by a tin guard so that the wind cannot scatter the paint.

The story would not be complete without some comparative data and, in this connection, it is said that by the old method four painters could stencil but a mile of road a day, whereas two men can cover from six to seven miles per day with the pneumatic spray-painting machine so ingeniously adapted to this work.



The air brush makes it possible to cover rapidly and effectually large areas that need painting.



The portable paint-spray outfit used in Wayne County, Mich., to mark center lines on highways for the convenience of motor traffic.

MAKING SHORT WORK OF PAINTING A POOL

By R. E. VELIE

IN ORDER to improve and to preserve the inside surfaces of an outdoor concrete swimming tank, maintained in the park of one of the smaller cities in New York State, it was decided by the park commissioners to drain the pool, to thoroughly clean it, and to give it a coat of paint. Thirty gallons of paint and fifteen gallons of reducer were ordered; and the specifications called for a mixture having rapid drying and good covering qualities—a paint sufficiently heavy to fill any pores that might be in the concrete. Thus, at one and the same time, the appearance of the tank was to be improved and the surfaces given a coating that would prevent seepage or loss of water by reason of porous concrete. A glossy white was selected as the proper coloring because of its clean appearance and of the fact that it would increase the visibility of the walls of the tank in the evening.

A portable compressor, mounted on a Ford truck and equipped with a paint-spraying outfit, was sent to the swimming tank; and no time was lost in putting it to work after the concrete surfaces had been thoroughly cleaned. The pool is 120 feet long; 40 feet wide; has a depth of 2½ feet at one end that gradually slopes down to 9 feet at the other end; and is constructed of concrete 10 inches in thickness. And let it be said here that all the surfaces, including the bottom—a matter of 6,640 square feet, were covered in the remarkably short time of 15 working hours, or an average of 443 square feet an hour.

It must be remembered that concrete is a difficult surface to coat with paint, inasmuch as it is composed of minute "hills and valleys" all of which must be covered in order to do a satisfactory job. On the face of it, a surface of this kind needs more paint for a given area than one of wood and would also take longer to cover. However, it was found that the pneumatic spray-painting method coated the concrete with entire satisfaction without leaving any excess paint in the tiny crevices and without the need of wiping thin the paint that adheres to the little ridges—work so often required when coat-

ing surfaces of this kind with a regulation bristle brush.

It so happened that the rapid drying qualities and also certain characteristics of the paint, which were somewhat similar to those of bronze or of aluminum, would have made it difficult to apply the mixture with a brush. As a matter of fact, the paint dried so quickly that it would have been a very slow process to have successfully spread it by brush after its application. Furthermore, it was necessary to continuously agitate the paint to prevent the heavier constituents from settling to the bottom. This was easily avoided in the case of the spraying system because the compressed air served to agitate the mixture in the tank.

The portable that provided the compressed air was a 5x5-inch Type Twenty machine, which is capable of maintaining a discharge pressure of 100 pounds and of furnishing 91 cubic feet of free air per minute—pressure sufficient to operate several paint guns at a time. Air was supplied for the job at 50 to 60 pounds pressure, and this was reduced in the tank so that it left the nozzle at 25 pounds pressure. During the fifteen hours that the compressor was running it consumed twenty gallons of gasoline, or an average of 1¼ gallons per hour.

CIRCUS FAN MAKES ITS BOW

ON A COLD day last spring, a card was handed to an official of the Westinghouse Electric & Manufacturing Company which read: "Mr. Francois of Barnum & Bailey & Ringling Brothers Circus." To make a long story short, Mr. Francois wanted to equip "the big tent," seating 2,200 people, with electric fans that were to fulfill the following three requirements:

1—Breeze from each fan unit must be felt at any point within a circle having a diameter of 50 feet.

2—The weight of each fan unit must be under 75 pounds.

3—Each unit must be so constructed that it can be dismounted and packed in fifteen minutes or less time.

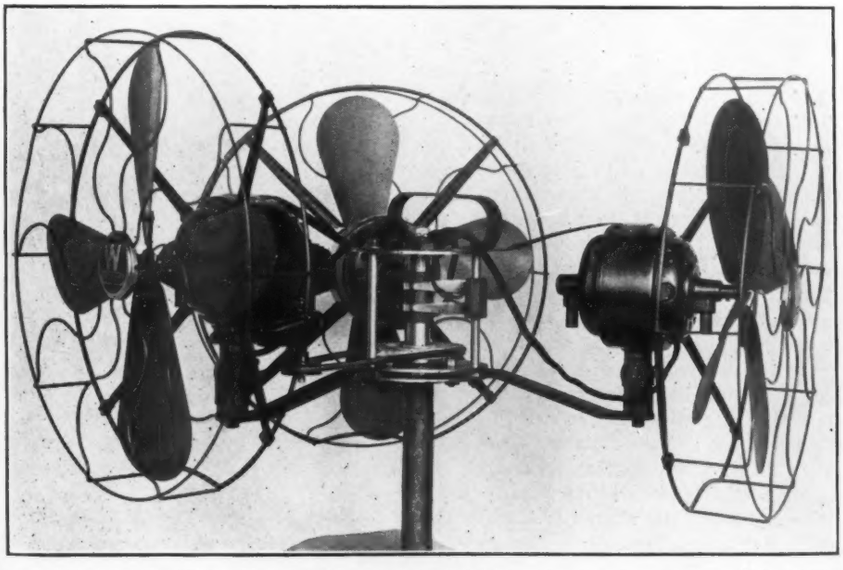
Circus fan installed where it can cool the animals when the temperature is high.

These requirements, simple as they may sound, really represented rather a large order. Gyrating and ceiling fans were eliminated at once, because a ceiling fan weighing 75 pounds cannot be hung from a canvas roof. Likewise, the standard type of desk fan would not serve as it could not be mounted on a canvas wall. Furthermore, the standard 16-inch gyrating fan has an oscillating arc of only 90° whereas Mr. Francois specified 360°.

It was finally decided to take two standard 110-volt, direct-current, 16-inch desk fans and one 16-inch oscillating fan and to construct a special type that would satisfy the requirements. The three 16-inch fans, as finally built, are mounted on a revolving carriage with extended arms. The carriage is supported by a piece of 2-inch pipe that is spear pointed so that it can be driven quickly into the ground. The fans revolve slowly at an approximate speed of twenty revolutions per minute. Current is supplied to the motor from collector rings carried on the pipe standard and properly insulated from grounds and short circuits by a micarta base.

The revolving motion of the fan carriage is obtained through a modification of the standard oscillating mechanism, as follows: The crank shaft, which oscillates the standard fan 90°, and the oscillating shaft with clutch were removed and a vertical shaft one inch longer was substituted. This shaft was extended through a hole drilled in the drip-pan cover; and a small grooved pulley approximately two inches in diameter was secured to the end of the extended shaft. This pulley was then belted to a larger pulley mounted on an iron standard.

The entire arrangement is decidedly ingenious and efficient. Current consumption is very little in excess of the standard consumption; and the total air delivery of each unit is 5,175 cubic feet per minute.



Rear view of the three fans with cover removed from the revolving mechanism to show how the latter is constructed.

AMERICAN PEACE AWARD

THE American Peace Award, created by Edward W. Bok and offering $100,000 to the author of the best practicable plan by which the United States may coöperate with other nations—looking toward the prevention of war, will make its choice known during the current month. Every citizen is asked to vote on the winning plan, which will be published in whole or in an abridged form in thousands of periodicals. We trust our readers will express themselves through the subjoined ballot.

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NEW YORK CITY.

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Compressed Air Magazine

—*Founded* 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:
Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries, $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

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EDITORIALS

The Season's Greetings

TO ITS old friends, and to the still newer friends which it confidently counts upon making, COMPRESSED AIR MAGAZINE offers greetings and best wishes for a very Happy New Year.

The Magazine feels that its success is largely what its friends help to make it, and it welcomes their support and encouragement.

INCOME FROM PANAMA CANAL IS MOUNTING

WE HAVE it on the authority of official Washington that the Panama Canal and its auxiliary agencies did a record-breaking business during the fiscal year ending June 30, 1923, both in the matter of financial returns to the United States Government as well as in the services rendered world shipping. In other words, the canal, alone, netted from all sources a profit of $12,063,880 in contrast with $9,201,613 for the preceding fiscal year. It seems that traffic operations have increased to such an extent as to bring the waterway to a point where it is "rapidly overhauling the Suez Canal."

Much of the expansion of the business during the period in question was due to the movement of California oil through the canal—60 per cent. of the eastbound cargo being made up of petroleum from that source. Among all the shipping using this man-made route, vessels flying the American flag represented the greatest gain in the traffic—increasing from 1,095 craft to 1,994 ships which carried 56.5 per cent. of the cargo transported through the waterway.

Analyzing the canal traffic by the principal trade routes using it, it would seem that the most notable growth was associated during the fiscal year of 1923 with the intercoastal trade of the United States; and Governor Morrow of the canal zone reports that "a great increase was effected in the traffic between the east coast of the United States and the west coast of South America—cargo moving over this route in both directions expanding from 793,123 tons in 1922 to 2,954,523 tons in 1923. Chilean nitrates and iron ore, and Peruvian oil were the most important single items in the total."

This gradual swelling of the tide of shipping, especially American shipping, through the canal should be a source of great satisfaction to us because we thus see that the primary value of the waterway is that of a trade builder and, therefore, an agency in booming the activities of peace.

MOTOR CARS AND STILL MORE MOTOR CARS

WITHIN the past few weeks it was reported that the Ford Motor Company was about to spend $110,000,000 in the course of a few months so that its plants might be able to turn out 10,000 cars daily by the early part of the new year. Assuming the working year to be one of 300 days, this would mean an annual output, when running at capacity, of 3,000,000 machines! Manifestly, this would clearly indicate faith in the capacity of the domestic market to absorb a great many more cars in a twelvemonth than is now the case; and this particular manufacturer is only one of a numerous group busy in the making of self-driven vehicles in the United States.

Not only is there a steady increase in the number of passenger cars absorbed by the domestic public but there is an ever-mounting volume of freight being hauled varying distances by a continually augmenting fleet of motor trucks. Indeed, it is becoming axiomatic among traffic experts that the motor truck must inevitably be recognized as an integral factor in the economical and efficient utilization of our trunk-line railways. Such being the case, it is imperative that due heed be given to the upbuilding and the maintenance of the country's public roads so that these arteries of communication will facilitate motor transportation and coöperate, where necessary, with the established steam lines.

Much has been written and much has been said about the expansion of the nation's highways; and a great deal of careful thought must be given this problem so that the gradual expansion of the vehicular roadways will keep pace in character and extent with present and future needs. Success in this great work will, of course, depend in no small part upon the materials and the mechanical facilities employed first to construct and thereafter to maintain these highways. Fortunately, many minds are today engaged in the study of this momentous question, and, happily, there are agencies which bring the essential facts to a focus just once so often.

One of the biggest aids in this special field of endeavor is the annual Good Roads Show, which is so effectively supported by the American Road Builders' Association and by the participants in the Highways Industries Exhibit. The fifteenth national convention of the Association will take place in Chicago during the current month.

COPPER THE UNIQUE

COPPER is unique among the metals and, if permissible, we would say "big unique" at that. It is the most ancient of all the minerals, far antedating all authentic history. Excavations in Egypt have disclosed copper tools and utensils which were in use before the building of the pyramids. Its industrial importance has grown without a lapse throughout the ages until, today, it is developing more rapidly than ever. Thus, as copper has dominated the past, so it will probably dominate the future; and its complete history can never be written as both ends of the story reach far away into invisibility.

Not only do we find limitations in the history of copper as related to its uses by man but, in discoursing on its other relations, the same difficulties occur. Copper is a typical and a phenomenal "mixer." It is found associated in one way or another with a great variety of substances. It exists in most soils and in ferruginous mineral waters; and all copper ores are always associated with something. It has been discovered in seaweed, in straw, hay, eggs, cheese, and meat—in short, in the liver and kidneys, and traces of it have been found in the blood of man and animals.

In the purely metallic state the mixing habit of copper still persists. In the Bronze Age, tin was to copper what the letter U is to the letter Q. In medieval, monumental brasses, zinc served in the same capacity. The alloys of copper, with a great variety of other metals and in an unlimited range of proportions, find responsible employment all through the arts, with often no available substitute. And yet, copper is as well if not better able to go it alone than any of the other metals.

Copper is frequently at its best, and most variously, extensively, and responsibly employed in its pure state. It is indispensable for chemical and culinary utensils and for piping of all sizes for an unlimited range of services; but, above all, it is a supreme requisite throughout the entire electrical field. It is not only essential in all the apparatus used for the generation and the manipulation of the electric fluid but it is especially needful for the transmission of the current far and wide

over the earth and under the seas—the maintenance of this latter service constituting the largest individual demand upon the sources of copper's production.

And speaking of the unique, we may say that a unique trick has been played upon copper through the recent developments of the electric busybodies. Who can say how vast will be the quantity of copper wire—until recently essential for purposes of communication—that will become unnecessary by reason of radio or wireless communication?

The demand for copper is in the constantly-growing category of the world's stored supplies, which the pessimists assure us must soon entirely fail us. The saving of copper by rendering it superfluous, which the radio system accomplishes, suggests how other things may similarly turn up in other directions to quiet our fears of exhaustion.

GLITTERING GEMS LURE US

AS A PEOPLE, we pay generously and freely for shining baubles; and it will probably surprise many of our staid citizens to learn that Americans have spent in the course of the last 55 years substantially $2,000,000,000 in the acquisition of diamonds. It has been hinted that the market for diamonds here has been greatly stimulated since prohibition was adopted by constitutional amendment—leaving us to infer that we are spending money on jewels where we used to spend it more lavishly on momentary excitement.

Be this as it may, statistics show that between 1867 and 1917, diamonds and other precious stones to the value of $771,544,558 were imported, and of this total, $750,000,000 represented the value of diamonds alone. When finally cut, set, and disposed of to the ultimate consumer in the United States, these gems were worth twice their import value. In the five years following 1917, our imports of diamonds amounted to $200,000,000. During 1921, our diamond imports reached $38,127,649, and in the succeeding year the diamonds entering our custom houses were appraised at $67,000,000.

The foregoing figures bear out the statement of Dr. GEORGE FREDERICK KUNZ, the eminent authority on precious stones, that our national hankering for diamonds is, if anything, becoming more pronounced with the passing of years. Whatever may be the promoting impulse, this demand for personal adornments is, in the last analysis, a fairly accurate indication of our prosperity as a people.

A FRENCH inventor, M. Dalery, proposes to use paper piping for water under pressure, and to produce it upon a commercial scale. The paper or light pasteboard is wound upon the shaft of a machine embodying a tank containing an adhesive substance. The last layers are impregnated with tar; and, finally, the pipe is given a covering of bitumen. An enlarged diameter is provided at one end, into which is fitted the smaller end of the succeeding section, and the joint is wound with a strip of tarred fabric.

COMMERCE YEARBOOK, 1922. This volume of 692 pages has been issued recently by the United States Department of Commerce and compiled under the direction of the Bureau of Foreign and Domestic Commerce. Published by the Government Printing Office, Washington, D. C. Price, $0.60.

THE YEARBOOK is published to meet the need not merely for a reference source, to be consulted only for specific facts on the recent past of business, but for a book which can be read for general commercial information and for a survey of the most important economic developments of the year. The outstanding facts of trade, production, price changes, and market conditions are conveniently tabulated and analyzed in relation to one another so that their interdependence may be readily recognized. Summaries are included of the principal manufacturing, mining, and forestry industries, of agriculture, construction, transportation, communication, finance, prices, and domestic and foreign trade of the United States, with reviews of the commercial and industrial developments in the principal foreign countries.

This book, the first of its kind to be issued by the Department, fills a long-felt want, and the business world will, undoubtedly, welcome it.

COSTS AND PROFITS, by Hudson Bridge Hastings, Professor-Elect of Administrative Engineering, Yale University. A work of 168 pages, published by Houghton Mifflin Company, New York. Price, $2.50.

IT IS a truism to say that the financial success of business is dependent upon the status of business as a whole, but it is a regrettable fact that all too many men in business are unaware of the basic conditions which at any given moment may turn the tide from a prosperous flood to a losing ebb. Professor Hastings has undertaken to demonstrate in an understandable fashion how costs and profits are interwoven with what he terms business cycles, and he goes to considerable pains to reveal how these cycles betray their coming. The book is a valuable contribution to a discussion of a subject about which more of the men in responsible administrative positions should have a better understanding.

ROBERT FULTON AND THE SUBMARINE, by William Barclay Parsons. An illustrated book of 154 pages, published by Columbia University Press, New York. Price, $4.00.

COLONEL PARSONS has done a useful service in placing before the American public a comprehensive story of Robert Fulton's work in helping to blaze the way for the modern submarine torpedo boat. The story of Fulton's activities in France in the latter part of the eighteenth and the early years of the nineteenth centuries has been more or less exhaustively covered by a number of French writers on naval topics. None of these books has been rendered into English, and, therefore, American readers have not had at their disposal data held in the *Archives Nationales*, in Paris. The present volume, however, makes good this lack, and, in addition, furnishes much other information which discloses how keen was Fulton's anticipation of what the submarine might prove to be in actual warfare. Colonel Parsons' contribution to the history of the submarine is timely and worth while.

CHARTS AND GRAPHS, by Karl G. Karsten, B.A., Consulting Statistician. A work of 724 pages, containing many illustrations, published by Prentice-Hall, Inc., New York. Price, $6.00.

IN THE LAST analysis, even though we boast of a very high state of civilization, our minds work easiest if not best along primitive lines. In other words, pictures are still potent aids in helping us to an understanding of many things in life. This is because a picture tells its story plainly, and does it with a speed and a certainty far beyond that ordinarily practicable with the written or printed word. Similarly, facts and figures of a complex order can be brought home to us most forcibly and effectually by means of some sort of graphic presentation.

Working upon this principle, Mr. Karsten has developed his subject in an entertaining and an authoritative manner; and in his book he shows us how graphs of various kinds can be utilized to assist in the elucidation and the ready grasp of statistics that might otherwise prove puzzling or utterly discouraging to the average mind. The book covers the preparation of many kinds of graphs and charts, and the author has been at some pains to explain the scope and the limitations of different types of charts and graphs. This work should be of much value to people engaged in popularizing statistics and to other workers in allied fields of endeavor.

FIELD BOOK OF COMMON ROCKS AND MINERALS, by Frederic Brewster Loomis, Professor of Mineralogy and Geology, Amherst College. A profusely illustrated work of 278 pages, published by G. P. Putnam's Sons, New York. Price, $3.50.

PROFESSOR Loomis has made a welcome contribution to the handbooks of the day, and has provided a little volume that will make it possible for us to add measurably to our pleasure when we roam abroad in Nature's breathing spaces. All too few of us can identify the rocks encountered on our jaunts; and most of us are ignorant of the names and the characteristics of the minerals held within these rocks.

Apart from their uses in the arts and the industries, rocks and minerals have stories to tell us of other ages and of far-off formative periods of the earth's crust. Professor Loomis lets us into the fascinating secrets of the distant past and discloses many things about these substances that we should know in order to round out our understanding of the environment in which we live and move.

CLEAN AIR FOR AIR COMPRESSORS

THE NEED of air free from dust and impurities for compressors, as well as for numberless manufacturing processes, is today generally appreciated. The ever-expanding effects of industry, together with the increasing use of soft coal and the rather general contamination of the air by objectionable and injurious gases, have made it plain that outdoor air is not necessarily clean air and have given rise to numerous attempts to provide a practical method for the removal of these impurities.

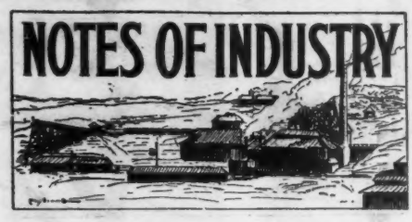
After exhaustive laboratory tests and three years of operation in various fields, it is claimed that the Reed system of air filtration offers a practical solution of many of the problems involved in the elimination of dirt and dust. This filter operates, fundamentally, on the same principle as the human nostril—the air in passing through the filter impinges on an indestructible metal filter medium saturated with simple chemicals, and the dirt and dust are leached out and deposited on the filter body. As the successive layers of dirt are deposited and bound on the filtering medium, additional "Adhesine" is supplied from reservoirs at the intersections of the media—in this way binding layer after layer of dirt and keeping the entire system moist for considerable periods.

Even if the individual fibers of the filter media collect a very thick deposit of dirt, the relative space between the fibers will not, so it is said, be appreciably decreased and the resistance will still remain very low. In passing through the filter, the air changes in direction from eleven to eighteen times, and each change in direction is caused by the air impinging on the chemically coated filtering media—producing, in this way, high efficiencies in dust removal.

The air filter consists of a light steel frame, containing a filtering medium of special metal wire. Both the cell and the filtering medium are subjected to a process which renders them proof against deterioration due to rust, acids, chemical fumes, etc. The cell and its filtering elements are practically indestructible; and the filter media are never removed from the cell—the units being supplied with handles which permit them to be easily cleaned and their tanks to be recharged with "Adhesine." When dirty, the cells are dipped in the cleaning tank, washed, and recharged—the entire operation requiring little time and labor.

A substantial frame made of steel channel iron is arranged to receive the filtering unit, each unit and frame forming a complete filtering system so designed that it can be quickly and easily attached to like systems, thus allowing for an expansion to meet almost any requirements as to space and capacity.

A monster steam shovel has been built in England for irrigation work in the Punjab, India. It is ten times the size of those usually employed for such work. Weighing 300 tons, including coal, it lifts 20 tons a minute and does the work of 600 men.



The Pennsylvania Railroad has recently placed orders for 475 locomotives of very heavy type and identical in every detail. The boilers are to carry a working pressure each of 250 pounds per square inch, and the cylinders will be 30½ inches in diameter with a 32-inch stroke. With that steam pressure, the thrust upon each piston will be above 182,000 pounds. The ten driving wheels carry practically the entire weight—giving enormous tractive effort.

A passenger-carrying airplane, classed as a supermarine flying boat, has begun making regular business trips between Southampton and the Island of Guernsey in the English Channel—the distance exceeding 100 miles. The machine leaves Southampton at 11.15 a. m., and alights at St. Peter Port about an hour and a quarter later. Returning, it starts from Guernsey at 3.30 p. m., and gets to Southampton in good time to catch the 5.26 train for London. The adult passenger fare for a single trip, including 30 pounds of baggage, is about $19.00.

The Bureau of Hygiene and Sanitation of the State of New Jersey requires that sandblast cabinets be equipped with reasonably dust-tight flaps, or equivalent protective devices, covering the openings through which the worker's hands must be inserted. There should also be a 3 or 3½-inch pipe, connected to an exhaust fan, maintaining a linear velocity of at least 2,000 feet of air per minute.

A large oil tank for a manufacturing plant—we are not told where—is located entirely below the surface of the ground. A pit was dug and filled nearly full of water. Then the empty tank was rolled in; the water was pumped out; and the job was completed without any parade.

In an address before the Michigan Good Roads Association, A. R. Hirst, Wisconsin State Highway Engineer, declared that the annual cost of owning and operating the 14,000,000 motor vehicles in the United States is approximately $5,000,000,000, and that the investment in these vehicles probably represents about $10,000,000,000.

In London, the Post-Office system of pneumatic tubes, through which telegraphic messages have for several years been sent from one post office to another and from the House of Parliament to the Central Telegraph office, is being extended by the construction of connections to the various government departments and to Downing Street.

The United States Department of Agriculture has been making some tests in the treatment of sugar-cane seeds by immersion in heated water. Immersion for periods of about twenty minutes, and at temperatures slightly exceeding 122° F., was found to completely destroy the animal pests, which persistently accompany these seeds, and also to stimulate earlier germination and increased growth.

An international commission, representing Belgium, Great Britain, France, Greece, Italy, Rumania, Jugoslavia, and Czecho-Slovakia, rendered a decision in Paris on October 15 for the adoption of the Westinghouse air brake for freight trains. The interpretation of the decision is that the Westinghouse brake is adopted as the official type, although the countries represented are at liberty to use other systems which can be coupled with the former.

It is proposed to reconstruct the celebrated Menai Strait suspension bridge of Wales, built by Telford 100 years ago. It was the pioneer of this modern type of bridge, and has well-nigh been left behind by latter-day construction. The central span is 580 feet with suspensions on each side of 280 feet. There are two 12-foot carriage ways with a 4-foot walk between them. The bridge shows signs of wear and old age which cannot longer be ignored.

The outstanding feature of the mineral industry for the year 1922, according to figures just compiled, was the recovery from the protracted slump of 1921, in common with other industries. The total value of all mineral products for 1922 was $4,652,000,000, an increase of 12 per cent.

Copper needs no introduction to Japan: that nation has used copper for generations. Long before the discovery of America, the Flowery Kingdom employed copper roofing; and on Nagoya Temple there is such a roof which is 625 years old.

Cakes of ice were put to a rather unique service not long ago by a California ice company during the construction of added plant facilities. In order to permit a 22½-ton tank to gradually settle on its permanent foundation, that company conceived the idea of placing the tank on blocks of ice which, in melting, carried the container to its footing without in any way wracking it.

Carbon black produced from natural gas in the United States in 1922 amounted to 67,705,000 pounds, according to the United States Geological Survey, and Louisiana and West Virginia yielded more than 90 per cent. of the total. An increased demand during the latter half of the year, especially by the rubber industry for use in making tires, absorbed all the output of the twelvemonth and, in addition, between 12,000,000 and 15,000,000 pounds that had been held in storage.